MODERN PLASTICS

MAY 1955

Plastics Prove Up in Safety Devices . . . Page 71

When and How to Paint Plastics . . . Page 99

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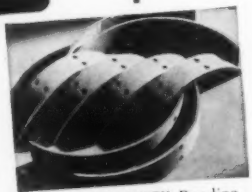

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MODERN PLASTICS*

May 1955 • Vol. 32 No. 9

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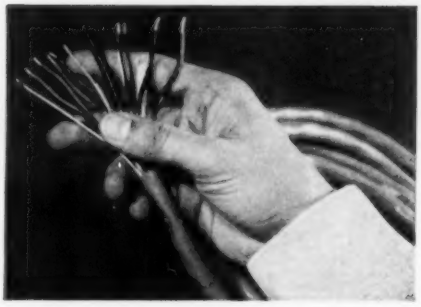

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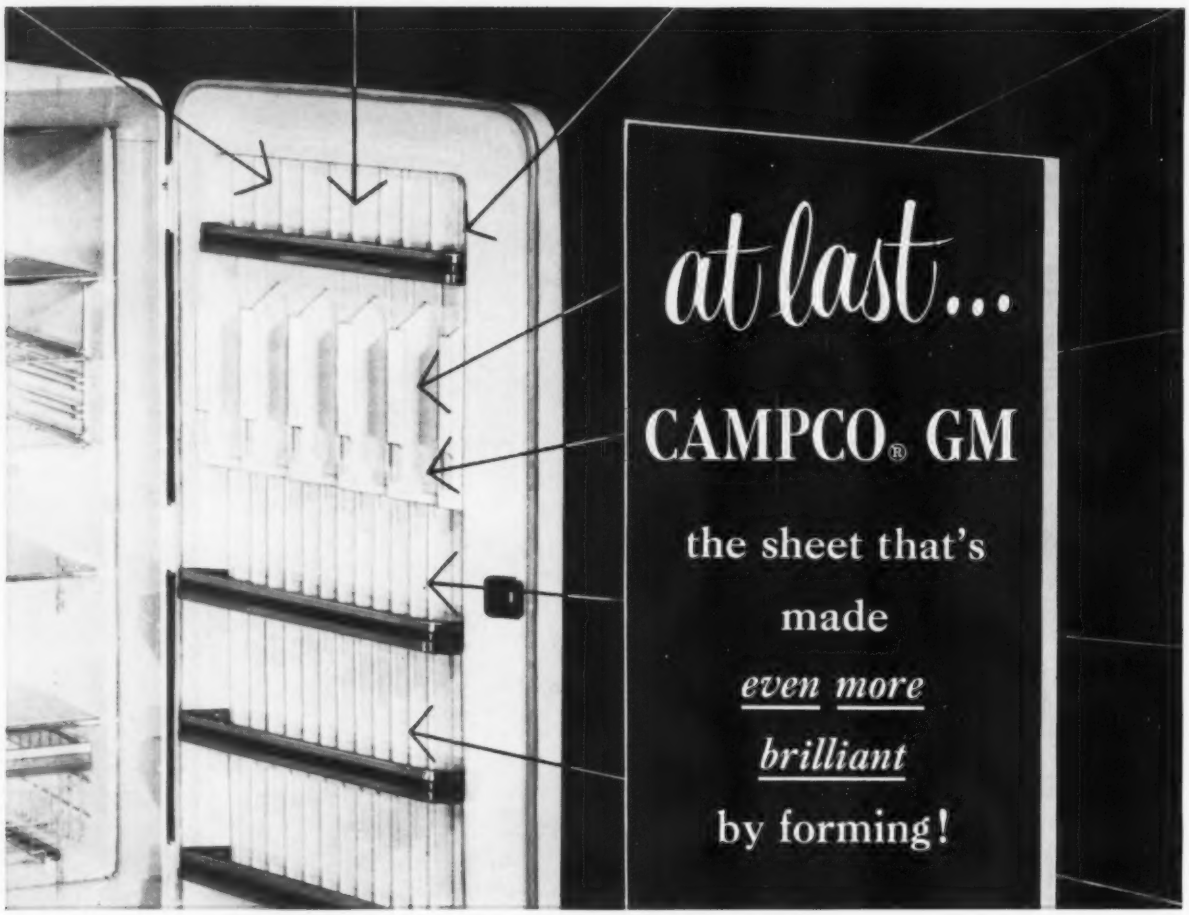

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EDITORIAL

The Importance of Definitions

Development of new materials and processes is so rapid in a young and vigorous industry that it is important that clear thinking be applied to the problem of terminology and definitions so that there may be not only clarity in discussions and literature within the industry, but also a sound public appreciation of the matters involved.

Take the case of reinforced plastics. From 1943 to 1946, since catalyzed polyesters were the chief materials used in that field, the expression "low-pressure plastics" was generally applied. Then it was found that other resins were involved, that considerable pressures were frequently desirable in the molding process, and that the chief element of interest was the fact that these resins could be reinforced for strength. So "low-pressure plastics" became, by mutual consent of most of the people involved, "reinforced plastics." Nevertheless, to this day, confusion created by the early erroneous definition persists to some extent.

Take the case of thermoplastic film and sheet coating and lamination. Until recently the way to put a thermoplastic film on another plastic film and the way to put a plastic film or sheet on cloth, wood, or metal was by the use of adhesives and the application of pressure and sometimes heat. Now polyethylene may be extrusion-coated or literally cast on other thermoplastic films or on paper. Vinyl may be applied to cloth, paper, or steel by knife-coating, roller-coating, or casting, as well as by laminating by platen or roller. The question is: Because the end results are apparently quite similar, should a product made by any coating process be termed a laminate?

This is no easy matter to decide. A number of interests are involved, particularly where a specification may read "or equal."

Still another important example comes up in the too-generous use of the term "vacuum forming." Three years ago the process of vacuum forming was being introduced and was heralded as a remarkable and economical new technique for making things out of thermoplastics. But as this new phase of the industry developed it was found that old forming techniques from the acrylic and nitrate industries involving both vacuum and pressure were in some cases preferable to the use of straight heat and vacuum. It was also found that new techniques or combinations of same had to be brought into play to accomplish all the things that needed to be done. In our lead article last month we showed seven distinctly different techniques currently being used in thermoplastic sheet forming. It is our opinion that oversimplification of definition by the too-glib use of the word "vacuum" could lead to later grief.

The plastics industry, in all its phases, is a busy industry. Often decisions relating to terminology must be made on the spur of the moment without enough reflection. And thus a misnomer may become part of the lore of the industry, causing minor or major confusion which may take years and a great deal of work to correct.

We offer no simple panacea for the problem, nor do we suggest the establishment of formal committees of nomenclature review. But we do feel it important to bring the problem and its implications to the attention of all concerned.

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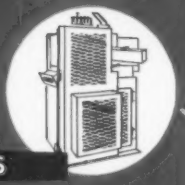

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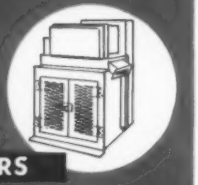

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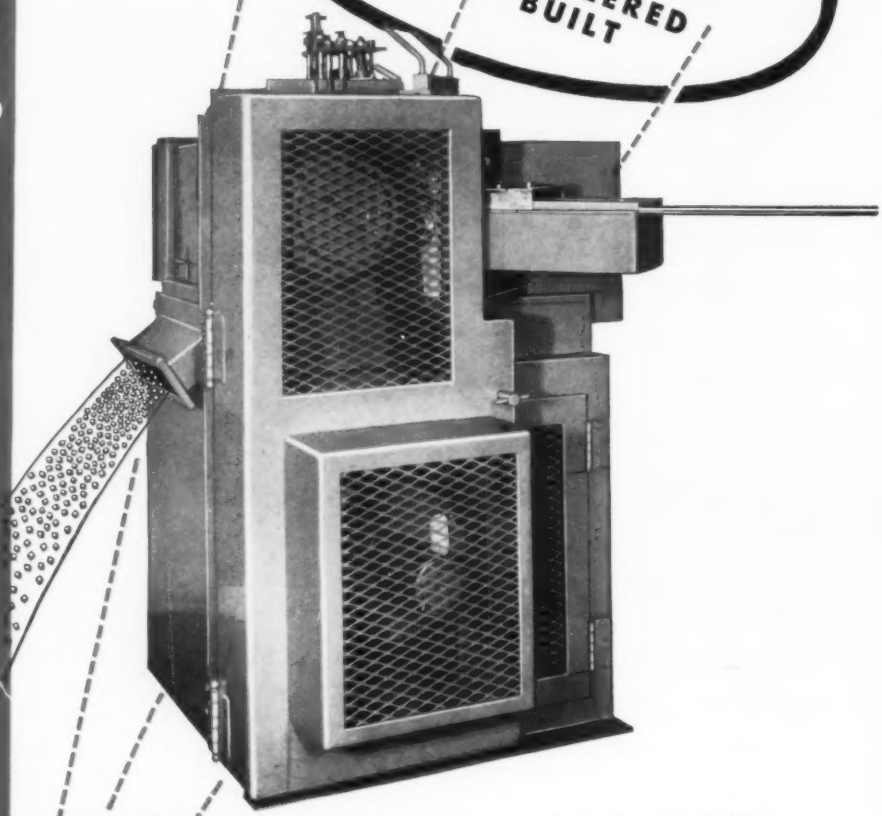

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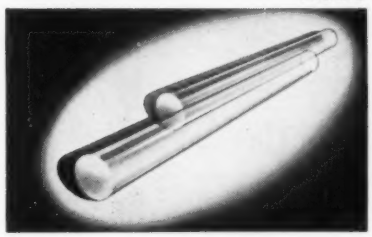
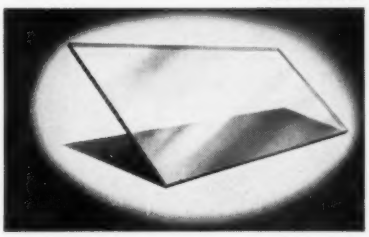


SHEETS



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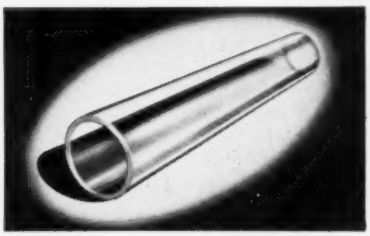

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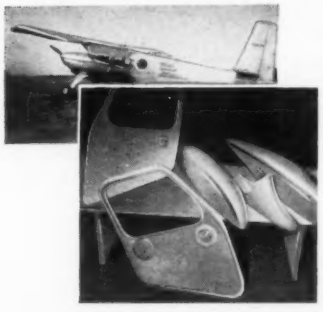

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CHEMICAL PROGRESS WEEK-MAY 16-21

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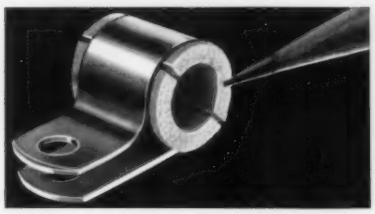
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 4 — 1955

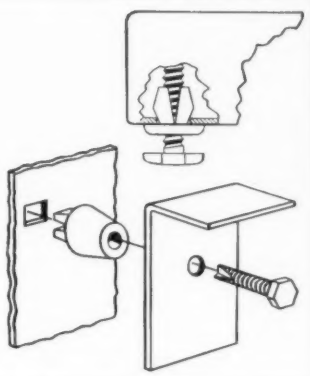
Design Engineers Develop New Grommets of "Zytel"* Nylon Resin to Reduce Breakage, Vibration

Clamp inserts of TEFLON® stop abrasion of aircraft wing hydraulic lines

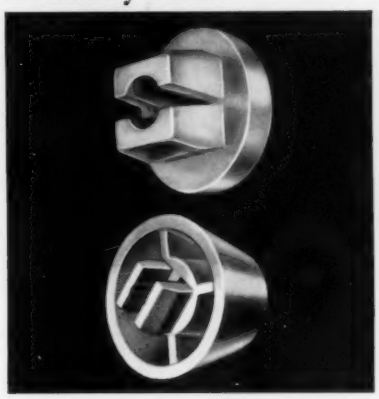


WHEN aerodynamic forces cause aircraft wings to undergo flexure in flight, wing hydraulic lines may undergo as much as six inches of movement. Aircraft manufacturers can now specify clamps with inserts of Du Pont "Teflon" tetrafluoroethylene resin to secure hydraulic lines that travel. Manufactured by Exacto Industries, Inc., Beverly Hills, California, with inserts of "Teflon" fabricated by W. S. Shamban & Co., Culver City, California, the clamps allow relative motion between hydraulic line and clamp, without abrasion. Natural slipperiness (self-lubricating) properties of "Teflon" tetrafluoroethylene resin allows hydraulic lines to move freely without being abraded.

Injection-molded "Zytel" eliminates extra parts; saves assembly costs



Top diagram shows how grommets of Du Pont "Zytel" nylon resin function as a leveling screw for a stove in the kitchen and (bottom) as a spacer between the inner liner and evaporator of a refrigerator.



Several types of "Plasti-Grommets". "Zytel" nylon resin is used for its resilience, strength, molding economy. (Grommets manufactured by Shakeproof Division of Illinois Tool Works, Elgin, Illinois.)

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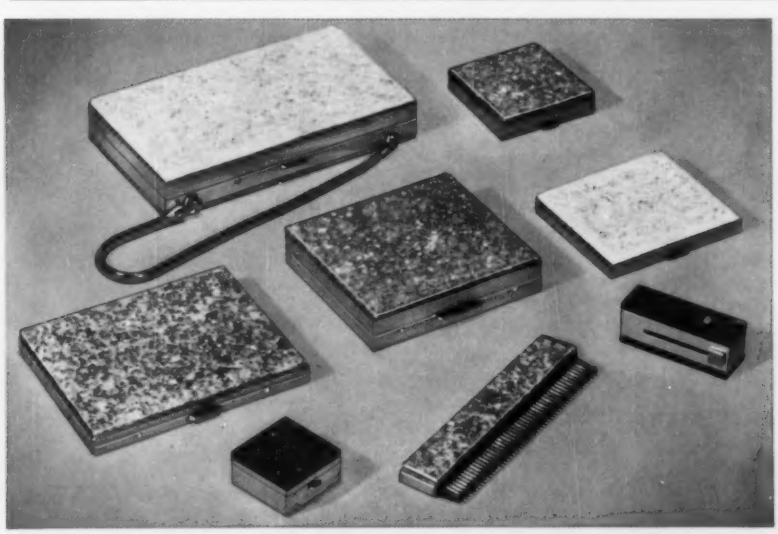
Can *your* operation be made more efficient and economical through the use of "Zytel"? Complete property information is available on this tough, wear-resistant engineering material. Simply fill out the coupon offered on the back side of this page.

OVER



These compacts carry decorative LUCITE® acrylic resin, in which colorful designs are embedded. "Lucite" is used today for many top-quality consumer items because it is long-wearing and easy to clean. It is also extruded into lighting fixtures of long-lasting beauty. For property and application data on Du Pont "Lucite", use the coupon on the other side of this page. Embedments of "Lucite" by Pearl Products, Inc., Glenside, Pennsylvania.

*"Zytel" is the new trade-mark for Du Pont nylon resin.

DU PONT

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 4 — 1955

Designers utilize properties of versatile "Zytel" nylon resin for bearing and for latch

THIS Shott chair has two 3/64"-thick bearings of "Zytel" nylon resin that permit smooth, quiet operation. The bearings of "Zytel" withstand abrasion and require no lubrication. (Chair manufactured by Balcrank, Inc., Cincinnati, Ohio.)

The Leco-Lon cupboard door latches of "Zytel", shown above, provide wear resistance, operate quietly, and hold door securely in place. (Latches made by Laboratory Equipment Corporation, St. Joseph, Michigan. Parts of "Zytel" molded by Hughes Tool & Manufacturing Co., Benton Harbor, Michigan.)

Connectors Utilize the Excellent Dielectric Properties of Du Pont TEFLON®

These connectors are insulated with "Teflon" tetrafluoroethylene resin—a material with exceptional dielectric properties and heat resistance. (Connectors manufactured by Industrial Products Company, Division of Danbury-Knudsen, Inc., Danbury, Conn.)

MOLDED "Teflon" tetrafluoroethylene resin is an excellent dielectric material—especially useful for miniature equipment where heat is often a problem. "Teflon" has a uniform dielectric constant of 2.0 in the frequency range of 60 to 10^9 cycles—insures that the connectors have a constant 50-ohm impedance. The high volume resistivity of greater than 10^{15} ohms cm. and low power factor of less than 0.0005 enable these connectors to carry RF power with practically no insertion loss.

Wide Temperature Range

"Teflon" has zero ASTM water absorption and a working temperature range that extends from −450° F. to 500° F. It resists corrosion from all chemicals except molten alkali metals and fluorine at elevated temperatures and pressures. Its ability to serve as a bearing, without lubrication (see front page—left column), is still another property that designers find useful.

Use the coupon on this page for complete property and application data.

Investigate Du Pont engineering materials in your product development programs

ONE of the family of these versatile engineering materials is often a key factor in product improvement or new design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"† nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 305, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME_____ POSITION_____

COMPANY_____

STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____

*"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
†"Zytel" is the new trade-mark for Du Pont nylon resin.

NOW... from MPM

A COMPLETE POLYETHYLENE FILM INSTALLATION

New High Speed Takeup Overcomes Many Previous Problems

● The components of MPM's new "packaged unit" for producing flat film and sheeting are matched and integrated. A product of five years of engineering development, they are more efficient and more accurate than any equipment previously available.

With polyethylene, this set-up extrudes film from .001" to .005" in thickness, up to a finished width of 54". Tolerance is much improved, as is essential both for economy and for less difficulty in printing. The same extruder and die extrude cellulose acetate and some formulations of unplasticized PVC. Takeups for those materials in thicknesses from .001" to .015" are also available.

The Extruder

The extruder in the "package" is an MPM 3½", world-famous for its outstanding construction, ease of operation and reliability. For film production the screw has been lengthened and thrust capacity is considerably oversize. MPM's new and exclusive stepless electronic temperature controllers regulate both the cylinder and the manifold type die.

The Polyethylene Takeup

The high speed takeup incorporates an adjustable water bath, pull roll, new efficient roll type trimmers, a unique air propelled cut-off and an automatic change-over from full to empty reels at full speed. The takeup is mounted on rails for easy removal when working on the die.

Like all MPM "packaged units" —for extruding blown film, for covering wire, for extruding rods and other cross sections—this set-up is furnished complete and ready for connection to water and electric lines. Full details supplied on request. Write today.

Demonstrations arranged

West Coast Representative
4113 West Jefferson St., Los Angeles 16, Calif.

modern plastic machinery corp. mpm
15 Union St., Lodi, N. J., U. S. A.
Cable Address: MODPLASEX

ENDLESS OPPORTUNITIES

come with calendered sheets of Plio-Tuf

Now, more than ever, there is no end to the opportunities for new profits with PLIO-TUF. Now PLIO-TUF is available as wide, calendered sheets that can be readily post-formed or mechanically fabricated into new or improved products of virtually any size or shape.

PLIO-TUF is a unique, high styrene copolymer—a pure, unplasticized resin—not a blend with rubber. It displays not only the usual properties of thermoplastic resins—hardness, stiffness, lightness, warmth and wide color possibilities – but an outstanding resistance to impact and unusual resistance to distortion by heat. Abrasion-, chemical-, electrical- and age-resistance also are above average.

PLIO-TUF is now being supplied as translucent or colored sheets in widths up to 54" in practically any length and in thicknesses of .010" to .040". Thicker sheets are possible through lamination of thin sheets. The sheets can be supplied in finishes ranging from highly polished to deep-grain embossed.

Sheets of PLIO-TUF are easily post-formed by vacuum or mechanical drawing. They are particularly suited to deep-drawing—have been drawn to a depth of nine inches or more without rupture. Once basically formed, they can be further fabricated by drilling, punching, sawing, sewing, cementing, sanding, buffing and painting.

Why not investigate the opportunities presented by PLIO-TUF as soon as possible? Sources of PLIO-TUF sheets plus literature on this versatile resin are yours by writing to: Goodyear, Chemical Division, Akron 16, Ohio.

CHEMICAL
GOODYEAR
DIVISION

Chemigum, Pliobond, Pliolite, Plio-Tuf, Pliovic—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

The Finest Chemicals for Industry — CHEMIGUM · PLIOBOND · PLIOLITE · PLIO-TUF · PLIOVIC · WING-CHEMICALS

PLIO-TUF . . . another quality product of Goodyear Chemical Division

NEW FORM OF PROFITS is this rigid calendered sheet of PLIO-TUF which can be readily post-formed or mechanically fabricated into an endless number of extremely impact-resistant products. Photo courtesy Plymouth Rubber Company, Inc., Canton, Mass.

MUEHLSTEIN

REPROCESSED PLASTICS

Don't let the profit slip away. If you use Muehlstein Polystyrene, Polyethylene, Vinyl and other Thermoplastic materials, you're guaranteed important savings in material cost. You rake in more profits! Special problem? Our new laboratory assures you top quality control, efficient color matches—complete satisfaction. Call on us today and save.

NOTE: We offer top prices for distressed inventories of molded parts, purgings and all thermoplastic materials.

WE BUY, SELL AND CUSTOM REPROCESS

H. MUEHLSTEIN & CO.

60 EAST 42nd STREET, NEW YORK 17, N. Y.

REGIONAL OFFICES: Akron • Chicago • Boston • Los Angeles • Toronto • London
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K-K--PLASTICS CAST FOR SPECIALIZED ROLES

Trapezo - flies thru the air—
withstands extreme temperature changes

Digesto - resists heat

Bulletini - withstands impact

The Great Pretzo - intricate shapes

If it's functional, "do-something" plastic parts that you need – not decorative or gadget-type castings – we've got what it takes to please you. Don't you need an outfit which, by specializing in functional parts for years, has become pretty functional-type itself, with realistic approaches to capabilities of plastic parts, their tooling, moulding and regularly scheduled, on-time deliveries? Then talk to us!

Our range is the whole gamut of thermosetting plastics from phenolics and glass-reinforced material to fluorocarbons and epoxies. Our desire is to work with you on mouldings like you see here. And our address is right here for you to write to. Why not?

KURZ-KASCH

Specialists in Thermo-Setting Plastics for 37 years

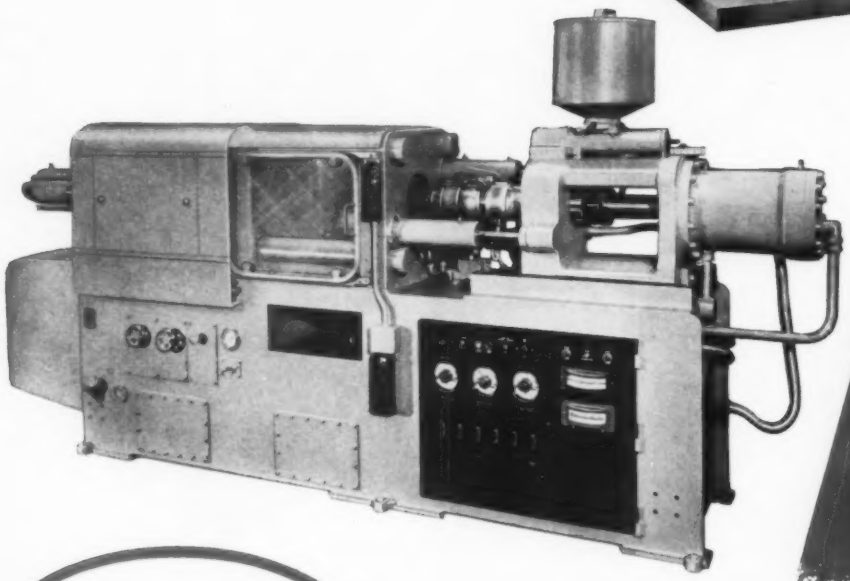
Kurz-Kasch, Inc. • 1415 S. Broadway • Dayton 1, Ohio

BRANCH SALES OFFICES: New York, *Mt. Vernon MO 4-4866* • Rochester, *Hillside 4352* • Chicago, *Merrimac 7-1830* • Detroit, *Jordan 6-0743* • Philadelphia, *Hilltop 6-6472* • Dallas, Logan *5234* • Los Angeles, *Richmond 7-5384* • St. Louis, *Parkview 5-9577* • Atlanta, *Exchange 0414* • Toronto, *Riverdale 3511*.

EXPORT OFFICE: 89 Broad St., New York City, *Bowling Green 9-7751*.

INJECTED or EXTRUDED

Above
PECO 2½" Universal Extrusion Machine



Left
PECO 20oz Injection Moulding Machine

PECO

MAKE THE MACHINES -THAT DO THE JOB

Peco Injection Moulding Machinery is now well established throughout the world as equipment in which the best engineering skill and experience are combined with the latest developments in plastic technology.

A recent addition to the PECO range of machines for the plastics industry is the 2½" Universal Extrusion Machine which is illustrated above.

Illustrated literature is available on all PECO products and will be gladly sent on request.

PECO PRODUCTS

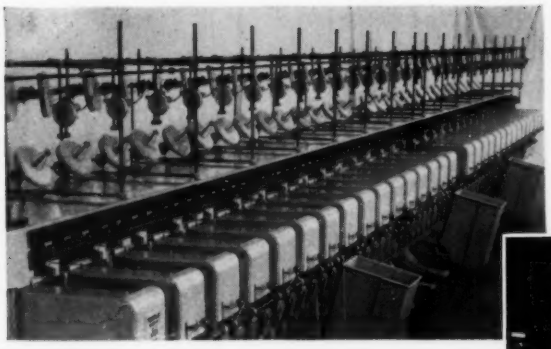
PECO MACHINERY SALES (Westminster) LTD.

28, VICTORIA STREET : : LONDON, S.W.I. : : ENGLAND

Telephone: ABBey 1793/4/5 Telegrams: PROFECTUS, SOWEST LONDON Cables: PROFECTUS LONDON

Reg. Office and Works

THE PROJECTILE & ENGINEERING COMPANY LTD ACRE STREET, LONDON, S.W.8



Perfect Partner for Metal

"U. S. Royalite saved us 66% in costs and gave us 7 outstanding advantages."

L. M. Sawtell
Foster Machine Co.
Westfield, Mass.

The giant machine shown above is a Foster Muschamp Model 66 bobbin winder. The empty bobbins (or pirns) which are fed along the top of the machine, drop off a belt into receivers known as pirn magazines. All day long these pirn magazines take a series of impacts at the maximum rate of one a minute. They must be TOUGH and DURABLE!

Duplicon, Inc., Westboro, Mass., specialists in combining plastics with metal, engineered, designed and produced this pirn magazine for Foster Machine Company by riveting easily formed, tough, versatile Royalite "2,000" to steel. In addition to the substantial material savings over all-steel construction, seven other advantages were quickly apparent:

- Lighter in weight.
- Noiseless during operation.
- Will not rust, even under high humidity.
- No painting necessary.
- Neater in appearance.
- Less expensive tooling.
- Greater flexibility.

U. S. Royalite "2,000" is the perfect running mate for all metals. It can be formed on low-cost tools, sawed, bent, punched or drilled, then bolted or riveted to metal. Learn all about this fabulous fabricating material by writing to:

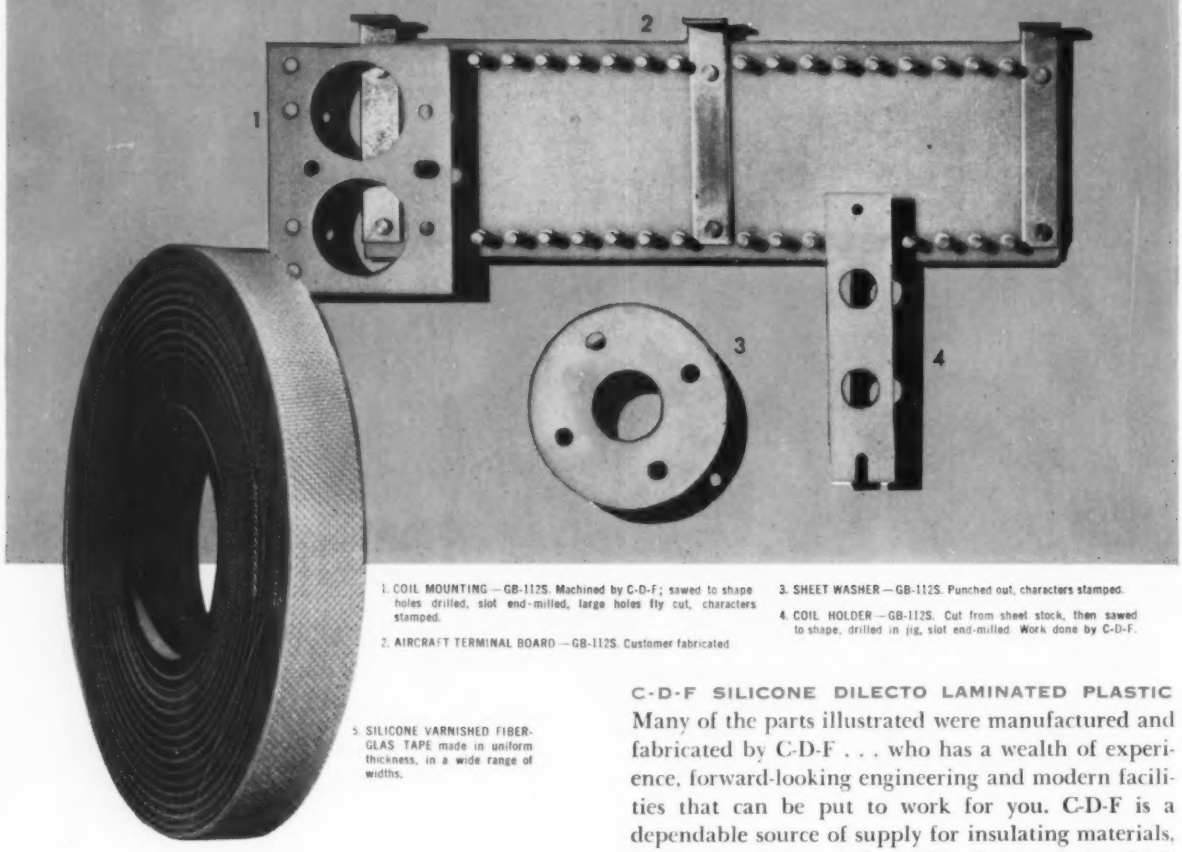
U.S. ROYALITE®
TOUGH, VERSATILE FABRICATING MATERIAL

US RUBBER

UNITED STATES RUBBER COMPANY
2638 NORTH PULASKI ROAD, CHICAGO 39, ILLINOIS

C-D-F SILICONES

For high temperature electrical insulation



1. COIL MOUNTING—GB-112S. Machined by C-D-F; sawed to shape holes drilled, slot end-milled, large holes fly cut, characters stamped.

2. AIRCRAFT TERMINAL BOARD—GB-112S. Customer fabricated

3. SHEET WASHER—GB-112S. Punched out, characters stamped.

4. COIL HOLDER—GB-112S. Cut from sheet stock, then sawed to shape, drilled in jig, slot end-milled. Work done by C-D-F.

5. SILICONE VARNISHED FIBERGLAS TAPE made in uniform thickness, in a wide range of widths.

C-D-F SILICONE TAPES are recommended for Class H insulation. It's been proved that silicone insulation has 10 times longer life than Class B insulation, even at the temperature limits of Class H. There are two types of C-D-F Silicone Tapes and Sheets: (1) Silicone varnished fiberglas; (2) Silicone rubber fiberglas. Each has the following properties:

- High temperature resistance
- High dielectric strength
- Low dielectric loss
- Resistance to moisture
- High tensile strength
- Flexibility

Both grades meet A.I.E.E. Standard for Class H insulation. They resist mild alkalis, non-oxidizing acids, mineral oils, oxygenated solvents. Silicone rubber fiberglas is recommended for many applications requiring a flexible abrasion-resistant material with good thermal conductivity. C-D-F Silicone tapes and sheets are available in a wide range of sizes in continuous rolls. For complete details, write for Technical Bulletin #47.

C-D-F SILICONE DILECTO LAMINATED PLASTIC

Many of the parts illustrated were manufactured and fabricated by C-D-F . . . who has a wealth of experience, forward-looking engineering and modern facilities that can be put to work for you. C-D-F is a dependable source of supply for insulating materials, and is noted for its fair pricing, for producing high quality products on schedule. Why not call in a C-D-F sales engineer on your problem. Or, write for Technical Bulletins:

#25—complete data on GB-261S, a fiberglas silicone laminate made of a staple filament woven fiberglas cloth and silicone resin in sheet form; #37—covers glass base silicone metal clad laminates; #42—post-forming grade of glass base silicone in sheet form; #23—GB-112S, fine weave continuous filament woven fiberglas with silicone resin, sheets, tubes, rods, molded shapes.

See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also, write for technical bulletin and specific catalog, free test samples, or send us your print for quotation.

CDF *Continental-Diamond Fibre*

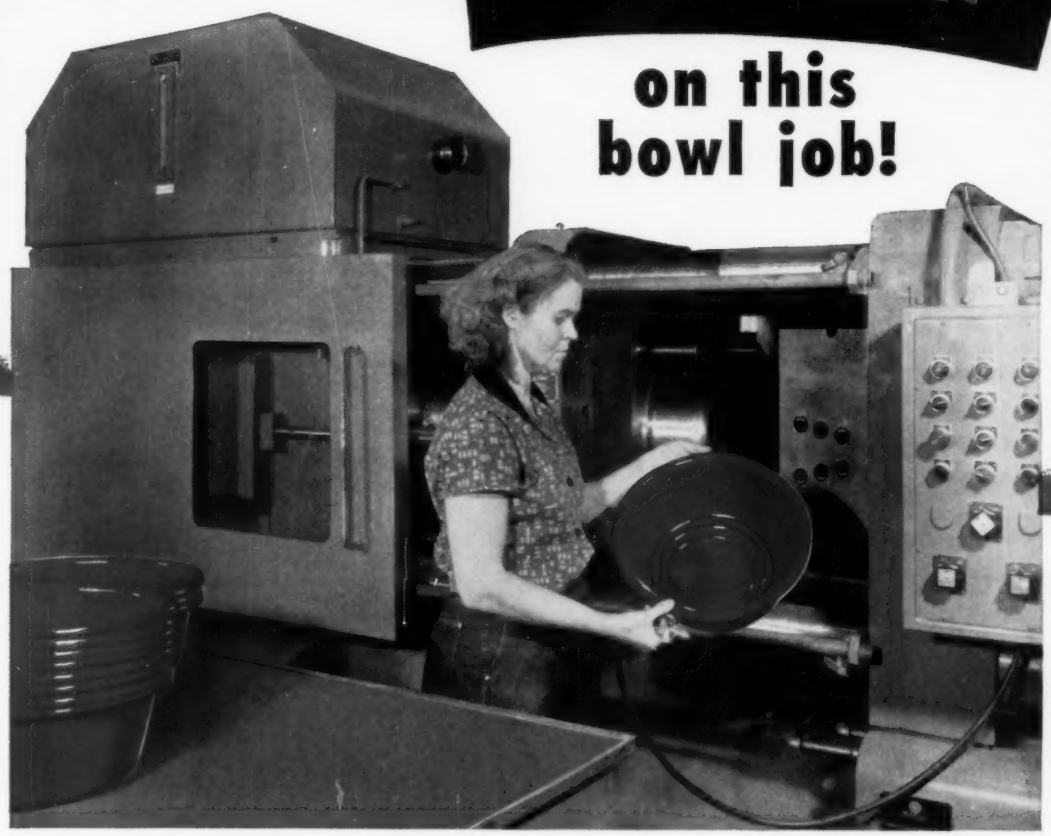
CONTINENTAL-DIAMOND FIBRE COMPANY

NEWARK 28, DELAWARE

H-P-M 20/28 oz.

40% Faster

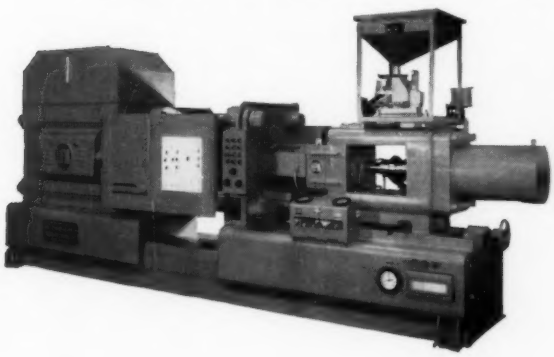
on this bowl job!



"It's the fastest machine we've ever seen and the quality of parts is excellent." That's what Universal Molding Company says about their new H-P-M, 20/28 oz. machine. "We can't tell you the production time on the 16 oz. polyethylene bowl, but it's 40% faster on our new H-P-M than on another machine of the same size."

Yes, this H-P-M 20/28 oz. is the best buy for the money! The heating chamber is larger than those found on machines twice its size . . . it's rated at 200 lbs./hour. Injection speed far exceeds anything yet built . . . 1330 cu. in. per minute. This big machine will dry cycle at full capacity in less than 15 seconds!

If you are molding parts in the 16 to 28 oz. class, you can't afford to overlook the production advantages of this new H-P-M, Model 400-H-20/28. Write for details, today.



HPM

THE HYDRAULIC PRESS MFG. CO.

1010 Marion Road, Mount Gilead, Ohio, U. S. A.

Presses for Every Pressure Processing Application

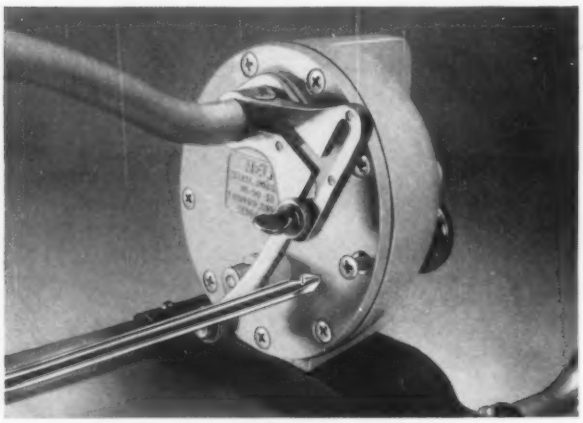
Are Your Fasteners HEADED FOR TROUBLE?

P-K STANDARDS protect you against these and many other symptoms of Screws "headed for trouble". They don't "get by" P-K inspectors—that's why *all* P-K Self-tapping Screws can be "Guaranteed First Quality".

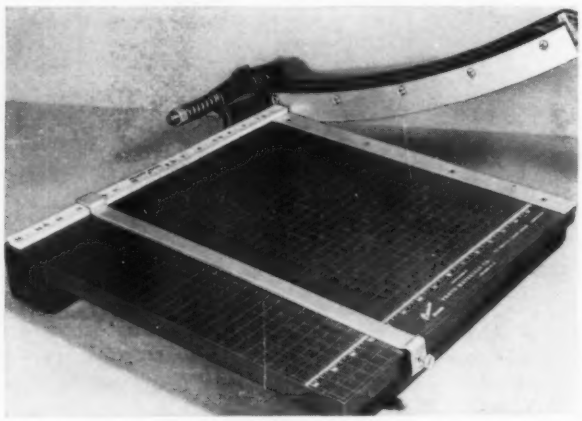
Screws are sometimes like people. If they "lose their heads" under pressure — if they turn out to be "softies" — if they don't "square up," they are headed for trouble.

The difference between screws made to P-K Standards and those that are "headed for trouble" is hard to see at a glance, but the effects of screw failure (parts spoilage, high reclamation expense, hidden weakness) are quickly evident in mounting assembly costs and customer complaints.

P-K Self-tapping Screws are "headed for savings" — not only headed, but threaded, pointed, and heat-treated with the same purpose — to keep your assembly lines trouble-free. That's why so many *more* manufacturers of America's best-known products specify P-K. For information on any fastening problem, talk to a P-K Assembly Engineer. Or write: Parker-Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14.



"SWINGIN' SPRAY," MELNOR Products Co.'s popular lawn sprinkler keeps on "swinging" because the oscillating mechanism is separate and sealed from the water intake system. To assure equally dependable assembly strength, resistant to the roughest handling, Melnor fastens zinc and aluminum parts with P-K Screws, 7 Phillips Head Type Z and 18 Type F, driven with air tools.



IN THE PREMIER CUTTING BOARD, made by Photo Materials Co., when 21 P-K Type A replaced wood screws to fasten the ruler, straight blade, bearing casting, and bottom cleats to the hard maple board, pilot holes were eliminated. The 5 P-K Type F Screws that now fasten curved blade to cast iron handle ended tapping. Power driving further speeds assembly.

PARKER-KALON®

The Original **SELF-TAPPING SCREWS**

IN STOCK . . . see your nearby P-K Distributor

Woodengraving made especially for this series by sculptor Ray Fink

The statue of Helios, better known as The Colossus of Rhodes, was the third wonder of the ancient world. Contrary to the popular belief that it straddled the harbor of Rhodes it actually stood much as the Statue of Liberty stands. Made of bronze and measuring 160 feet high, it had a spiral staircase inside leading to the eyes and served as a beacon for ships at sea. A tragic earthquake toppled this giant a little more than fifty years after it was built. But for 800 years travelers marveled at the huge fragments strewn along the shore.

Today, Plenco brings you a modern marvel with its wide range of quality controlled phenolics. If you have a plastics problem we feel certain we can help you as we have helped many others.

PLASTICS ENGINEERING COMPANY
Sheboygan, Wisconsin

PLENCO PHENOLICS
FOR BETTER PLASTIC PRODUCTS

How Chlorowax® can help you push down vinyl compounding costs

When you are looking for ways to cut costs . . . look at Chlorowax 40 as a secondary plasticizer.

It has a proved record of many cases where it has cut compounding costs by 1.5c to 2.5c per pound volume, without impairing the finished product. In some instances, it has improved quality.

Here are some of the other advantages processors get with Chlorowax compared with other secondary plasticizers:

Low Volatility—Lower than DOP.

No Odor—Important near foods and in closed areas.

Non-Toxic—Eliminates another limiting factor.

Non-Migrating—Reduces lacquer lifting.

Amounts of Chlorowax 40 that can be used as a secondary plasticizer and other helpful data are covered in DIAMOND Chlorowax Bulletin No. 9. Write for your copy, today.

DIAMOND ALKALI COMPANY, Chlorinated Products Division, 300 Union Commerce Building, Cleveland 14, Ohio.

DIAMOND ALKALI CHEMICALS®

Diamond Chemicals

CHEMICAL PROGRESS WEEK-MAY 16-21

A BETTER AMERICA THROUGH CHEMICAL PROGRESS

...gives rapid cure, excellent appearance, high torque strength!

This newest Borden phenolic molding powder was developed especially for high speed molding operations . . . for applications such as closures, buttons, and wire fasteners.

It's DURITE SG-713, a single-stage powder available in black or brown. It is bleedproof and has minimum odor . . . combines the highly important characteristics of rapid cure speed, excellent appearance, and high torque strength. Because of its carefully controlled batch-to-batch uniformity, you will find that it simplifies molding operations . . . assures consistent high quality in your finished products.

If you mold with phenolic compounds, it will pay you to write for a sample of Borden's new DURITE SG-713 . . . or have a Borden technical representative demonstrate its many advantages in your plant. The Borden Company, Chemical Division, Durite Products Dept. MP-55, 5000 Summerdale Ave., Phila. 24, Pa.

DURITE

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THE *Borden* COMPANY

CHEMICAL DIVISION

PHENOLIC MOLDING COMPOUNDS • ABRASIVE AND FRICTIONAL BONDING RESINS • MOLDING AND SPECIALTY RESINS • LAMP BASING CEMENTS

Mold for injection-molded plastic barrettes

DURAMOLD A

DURAMOLD B

Multiple-cavity die for making plastic wall tile

THERE'S A GRADE OF DURAMOLD FOR EACH COLD-HOBBING APPLICATION

If you're engaged in the cold-hobbing of plastic dies, it will pay you to look into the advantages of Duramold, the tool steel which is made by Bethlehem especially for such applications.

Duramold comes in three types: A, B and C. All three have the characteristics necessary for economical service in cold-hobbing. Each of these high-quality steels is clean, free from surface and internal defects, and is capable of producing dies which take a mirror-like polish.

DURAMOLD A. The air-hardening grade with high core-strength (RC-30). Annealed to 109 max Brinell, resulting in easy hobbing. After carburizing, the surface can be polished to a high lustre.

DURAMOLD B. The oil-hardening grade. Excellent combination of high core-strength (RC-15) and ease of hobbing. Annealed to under 100 Brinell. The boron addition increases its core-strength, with no detriment to hobbing.

DURAMOLD C. The water-hardening grade. A low-carbon hobbing steel. Easiest to hob, as it is annealed to 90 max Brinell. Can develop case hardness of RC-62.

DURAMOLD C

Mold used in manufacture of plastic door catch

If you would like complete information about these cold-hobbing grades, or about Bethlehem tool steels for master hobs and machined-cavity dies, write to the nearest Bethlehem sales office, or get in touch with your Bethlehem tool-steel distributor.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM TOOL STEELS

BETHLEHEM STEEL

X-ray "Private-eye" of quality control...

You are looking at the beginning of a quality control step that used to take over four hours—now it's done in six minutes! A specimen of Glidden Rutile Titanium Dioxide is being readied for exposure to 4 X-ray beams in the Diffractometer. The "magic eye" of this unit will determine the degree of rutilization in the pigment, then amplify, count and record the data. It's all part of the extra care that Glidden takes to assure you the highest quality pigments—Rutile and Anatase Titanium and Cadmolith Reds and Yellows. Ask now for detailed information on these products of Glidden Planned Research.

THE GLIDDEN COMPANY

Chemicals • Pigments • Metals Division

Baltimore, Maryland • Collinsville, Illinois • Oakland, California • Hammond, Indiana • Scranton, Pa.

CHEMICALS
PIGMENTS
METALS

QUALITY
Glidden
PRODUCTS

R/M DEVELOPS CUSHIONED GLASS FIBER WARP FOR USE IN WOUND STRUCTURES

Novabestos Cushioned Glass Fiber Warp is a new construction offered by R/M for such structures as rocket launchers and Jato. It is an evenly spaced warp of 150's glass yarn sandwiched between 4 mil thick cushion layers of asbestos fiber paper—and fully bonded with B stage polyester or epoxy resin. Flexible, tough and slightly tacky, it can be easily and safely handled as a sheet or tape. Its crosswise stretch allows curvature conformation. When laminated at 15-50 psi, a highly directional solid reinforced structure of unusual properties is obtained:

tensile strength	**48,000 psi**
tensile modulus	**6.4 x 100 psi**
flexural strength	**81,500 psi**
columnar compression	**49,600 psi**

Write on your company letterhead for a free copy of a brochure containing technical and design data on R/M's unique line of Novabestos Papers, Pyrotex Felts, and Asbestos Cloths.

RAYBESTOS-MANHATTAN, INC.

ASBESTOS TEXTILE DIVISION, Manheim, Pa.

FACTORIES: Manheim, Pa. • Bridgeport, Conn. • No. Charleston, S.C. • Passaic, N.J. • Neenah, Wis. • Crawfordsville, Ind. • Peterborough, Ont., Canada

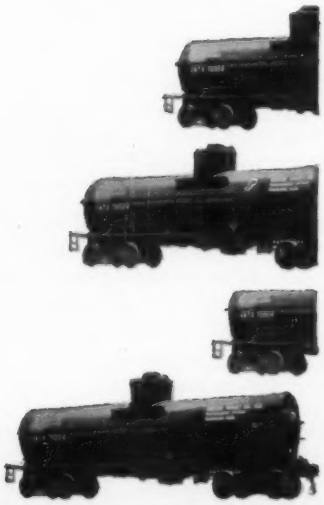
RAYBESTOS-MANHATTAN, INC., Asbestos Textiles • Abrasive and Diamond Wheels • Packings • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Rubber Covered Equipment • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Bowling Balls

A product of progress

THROUGH INTEGRATION

FOSTARENE®

A VIRGIN POLYSTYRENE



Fostarene is produced by an independent practical molder dedicated to present and future uses of polystyrene...backed by long, successful experience ...tested and proven in injection molding production.

FOSTARENE IS AVAILABLE IN PELLETS AND GRANULES.

EXCLUSIVELY REPRESENTED BY:

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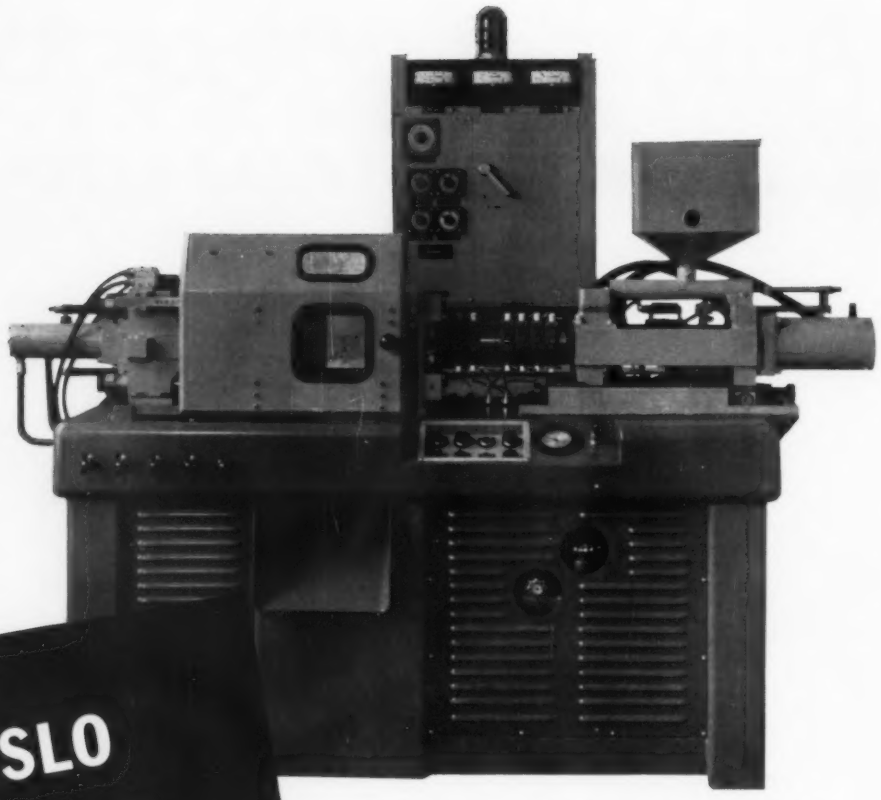
FOSTARENE® PETROCHEMICAL DIVISION **FOSTER GRANT CO., INC.** LEOMINSTER, MASS

A PIONEER IN PLASTICS FOR OVER THIRTY YEARS



MOSLO

presents a new SUPER 2-OUNCE PLASTIC MOLDING MACHINE

Moslo stays in front with a hydraulic plastic molding machine *that has everything.* Known as the 74, it is similar in design, but twice the weight and strength of the former Model 73. This new model is the *fastest* and *heaviest* small machine on the market. Designed to handle the tough jobs, the Model 74 is a really super deluxe, 2 ounce machine.

Check these outstanding features and see why the Moslo 74 is your best bet.

1. AUTOMATIC LUBRICATION of entire clamp mechanism.
2. HYDRAULIC INJECTION BOOSTER arrangement supplies full pressure for entire injection stroke.
3. HIGH SPEED PRODUCTION—plasticizing capacity of 50 pounds per hour.
4. FAST OPERATION—1250 cycles per hour (dry run).
5. HEAVY DUTY—Welded steel base and heavy gauge materials provide for sturdy and rugged construction.
6. HYDRAULIC MANIFOLD eliminates 60% of fittings and simplifies maintenance.
7. AUTOMATIC CONTROLS and SAFETY DEVICES assure maximum protection to operator, material, and machine.
8. MOLD SIZE—9″ x 12″.
9. MOLD CLAMP—75 tons.
10. PLUS FEATURES—incorporated in every Moslo machine are many exclusive features that have been developed from years of experience in the molding machinery business.

In addition to Model 74, Moslo also has available a sturdier Model 73 2 ounce machine. This model is a standard version of the Model 74 with fewer deluxe features and smaller plasticizing capacity.

Investigate Moslo before you buy any plastic molding machine.
We invite your inquiry and will be glad to send you additional information.

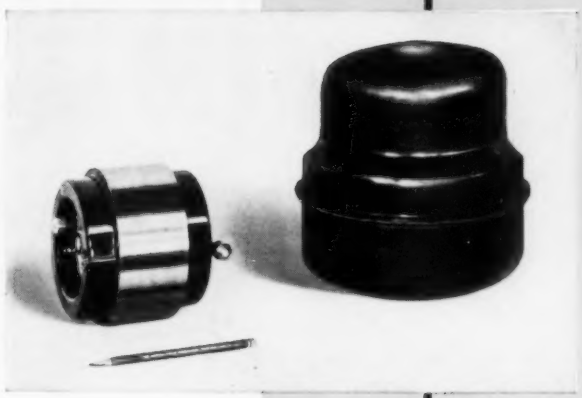
MOSLO MACHINERY COMPANY

2443 PROSPECT AVENUE • CLEVELAND 15, OHIO

with the help of EPON® RESIN...

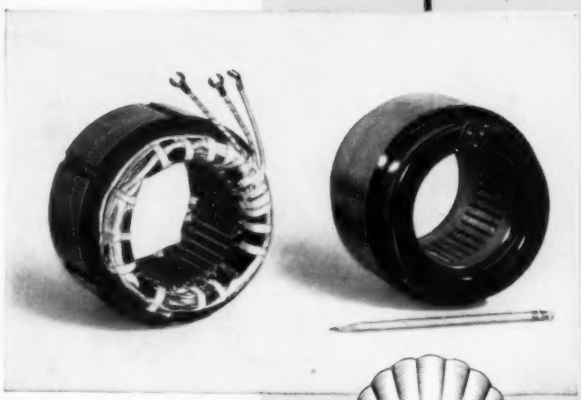
Motor stator becomes pump housing as well—

in new, ultra-compact, refrigeration motor-compressor



New Compressor (left) takes only 27% of the space of a conventional unit (right). It has only 10% as many parts, weighs 58% less, and will cost much less to produce.

Assembled stator (left). Finished stator (right) has been potted with Epon resin formulation. New compressor was developed by Wetmore Hodges and Associates, Redwood City, California.



Why not combine the pump and the motor? Put a gear pump *inside* the motor stator, encase the stator in plastic, and you can build an entire motor-compressor in the space occupied by a conventional motor alone!

Wetmore Hodges and Associates have done just that. But along the way, they ran into an unexpected problem. With the motor stator doubling as the pump housing, it had to be pressure tight . . . free of voids. This was impossible to achieve with standard potting compounds.

After hundreds of plastic formulations were tried, an Epon resin-based compound solved the problem. The Epon-impregnated stator proved to be pressure tight, stable mechanically and fully resistant to Freon at 350 psi, at temperatures as low as –20° F and as high as 250° F. Important too, Epon resin has excellent dielectric properties; is impervious to air, oil and water.

If you, too, are interested in plastics for electrical applications, write for technical bulletin "Epon 828 in Casting Applications."

SHELL CHEMICAL CORPORATION

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You save when you order the sheet TAILORED to the job

This actually happened! A Nixon salesman in a customer's plant noticed pounds of Nixon formable sheet being trimmed and scrapped. "But why all this waste?" was his logical question. "Why not let us make the sheet to fit your job?"

Nixon helps to save you costly wastes, saves you valuable production time. Check your measurements carefully before you order. Nixon will make the sheet comply, wherever reasonable, or come so close you'll still be way ahead in time and savings.

This helpful service applies to all Nixon high quality formable sheet material. Always available in a wide range of colors, gauges and (of course) standard sizes. Just one of the many services you can expect from one of the oldest, most reliable names in the plastic industry.

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Canadian Distributor: Crystal Glass & Plastics Ltd.,
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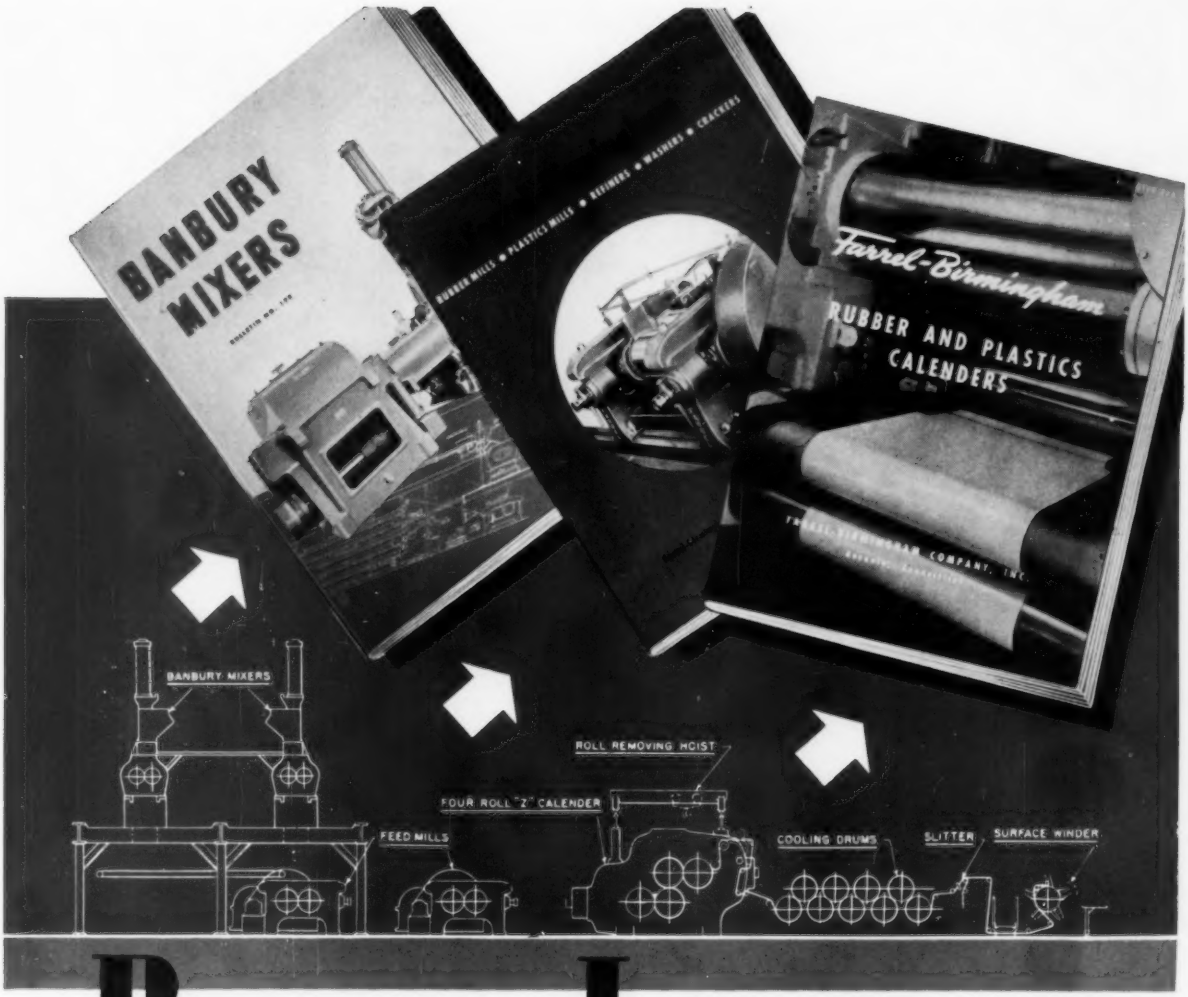
Nixon
PLASTICS



REFERENCE LIBRARY

for an efficient film production line

The three bulletins illustrated describe the major components of the processing setup blueprinted above. They contain details of the latest developments in processing methods and equipment, as pioneered by Farrel-Birmingham in the last few years, as well as illustrations, general specifications, information on related equipment and other pertinent data.

The processing setup is one of a number developed by Farrel-Birmingham to synchronize the progressive steps in the production of plastic film, sheet and coatings. These matched production units have given such satisfactory service that they have become generally accepted as standard equipment. For individual requirements, demanding greater or lesser output, larger or smaller machines with matched capacities are available.

Write for copies of these fact-filled bulletins today. There is no obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.

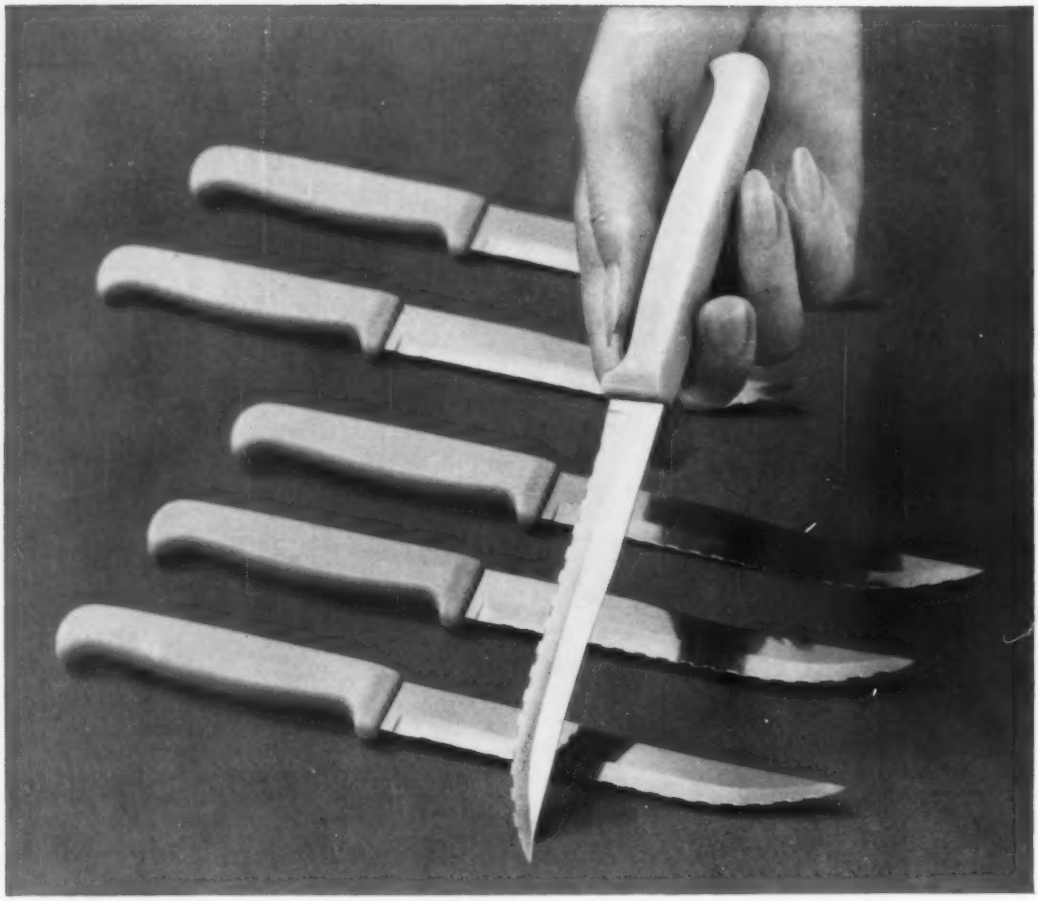
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham®

FB-919

hercocel®

FOR PREMIUMS THAT MOVE MERCHANDISE



SOLID COLOR pistol-grip handles, combined with highly polished steel, grace any table setting. These units and others, in a wide assortment of gift items and sets, are manufactured by Quikut, Incorporated, Fremont, Ohio.

Hercocel—the high-quality acetate plastic—is the perfect companion for Quikut's high-quality, stainless steel cutlery. It's a combination that cannot help but move merchandise fast—with a value far beyond the premium's actual cost.

Quikut uses colorful Hercocel handles for the two types of hollow-ground knives shown here—in glamorous "pearl" and handsome solid colors. Durable and washproof, these handles retain their luxury look and feel through years of use.

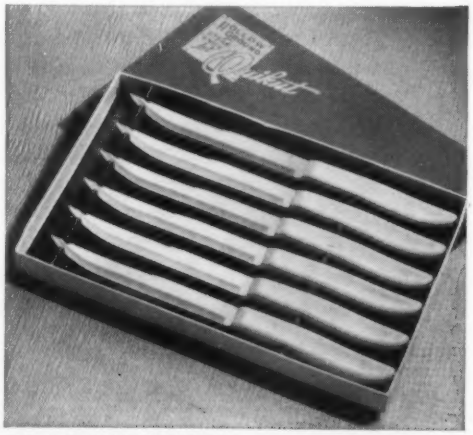
Premium buyers who want beauty, utility, and sell appeal at modest unit cost look for products made with Hercocel—the high-economy, high-quality plastic.

Cellulose Products Department

HERCULES POWDER COMPANY

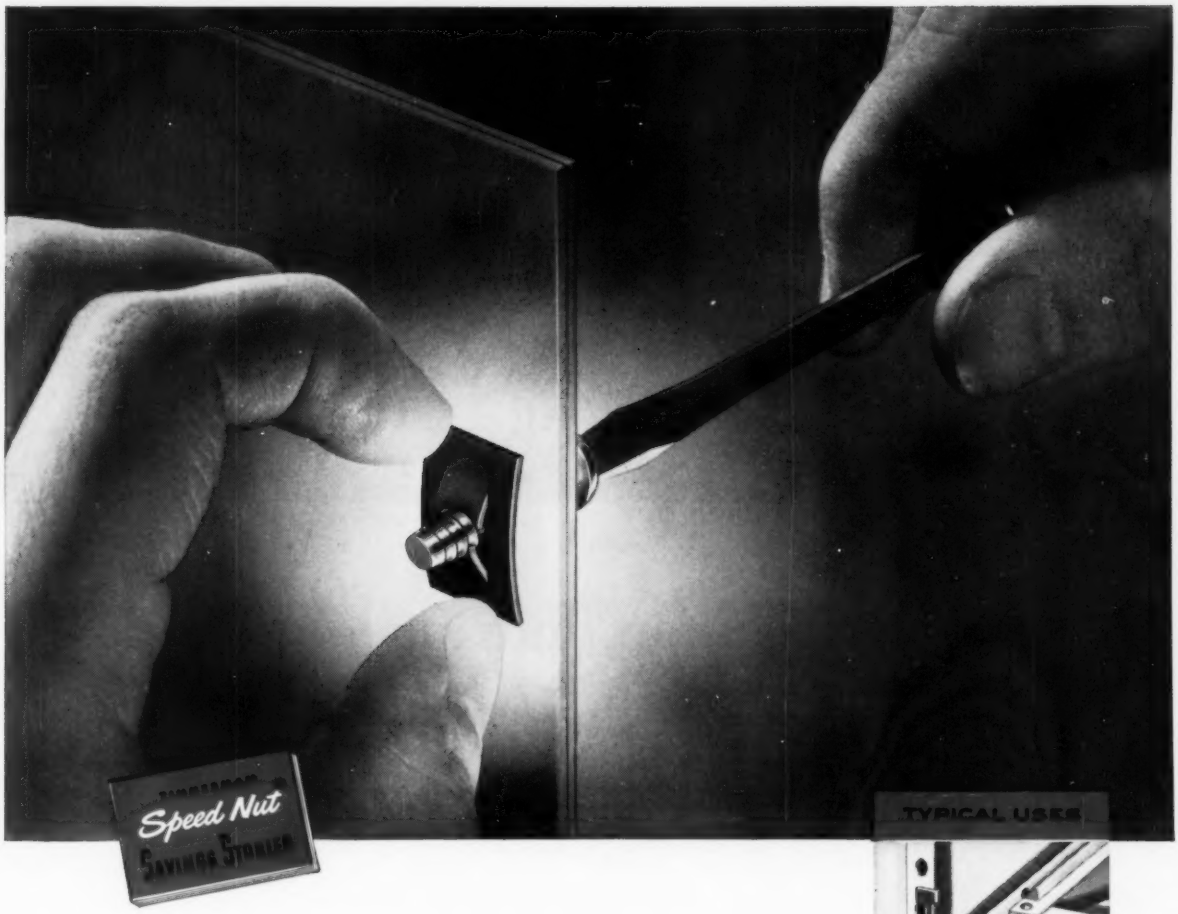
INCORPORATED

916 Market Street, Wilmington 99, Delaware



GLAMOROUS "PEARL" Hercocel handles give a rich luxury look to this line of Quikut stainless steel knives.

CP55-2



Savings that come from tough little Arches of Steel

This is a familiar sight on assembly lines today . . . a Tinnerman SPEED NUT being pulled down tight on its screw, never to shake loose from vibration. Yet easy to loosen at the proper time without worry about rust-frozen screw threads.

The secret lies in the arched base and prongs of the SPEED NUT. As the screw is tightened, the flexible SPEED NUT flattens, setting in action two distinct forces that lock for keeps. Yet a firm twist of the screwdriver is all that is needed to relieve those forces and loosen the fastener.

Savings in unit cost, in man-hours of application, in parts handling, are the important reasons why SPEED NUT brand fasteners are in service on your automobile, television set, home appliances and other assembled products. Write for "SPEED NUT Savings Stories", actual case histories of short cuts to assembly and production savings.

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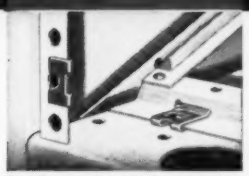
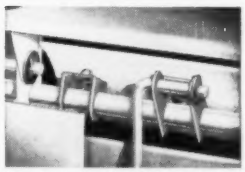
Canada: Dominion Fasteners, Ltd., Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN **Speed Nuts**®
FASTEST THING IN FASTENINGS®

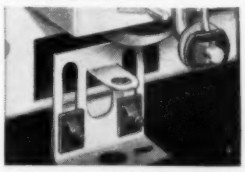
TYPICAL USES



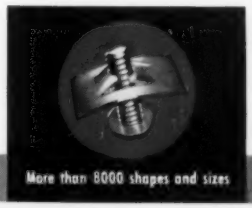
Total cost of control-equipment enclosure reduced by 30% with "J" type SPEED NUTS!

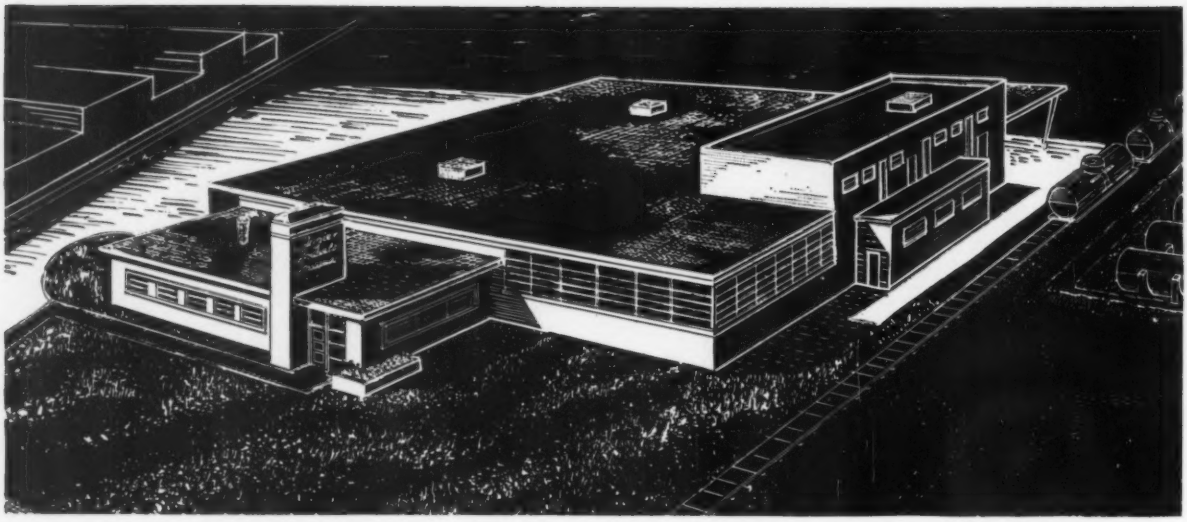


Specially developed SPEED NUTS cut assembly costs of adjustable awning by 63%!



SPEED NUTS lower assembly costs 40% on casement-window air conditioner!





Your Huntington, Indiana Source for Adhesives and Coatings is now ready

In effect, Angier's modern facilities at its new midwestern plant are *yours* also. Because "custom" manufacturing of adhesives, coatings and sealants will go on there just as it has for over 20 years at the home plant in Cambridge, Mass.

For a variety of reasons involving time and money, you may prefer the Huntington, Indiana location to the Cambridge location. Just remember that Angier is now able to make overnight delivery to all Eastern and Midwestern major cities.

Will an adhesive or coating improve the end-use of your product or cut its production costs? Angier will find the answers for you in surprisingly short time.

Call or write Dept. A at the nearest Angier Plant for personal attention. We will help you define your problem as well as solve it. Inquiring will not obligate you in any way.

FOR EVERY INDUSTRY

Latest Developments in Pressure Sensitive Cements

ANGIER PRODUCTS INC.

Rubber, Latex and Resin Cements
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Angier Products

Main Plant: 120 POTTER STREET, CAMBRIDGE 42, MASS.

Midwestern Plant: Huntington, Indiana

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dioctyl azelate

dimethyl phthalate

di-(methoxyethyl) phthalate

di-isobutyl phthalate

diethyl phthalate

dibutyl phthalate

di-isobutyl adipate

triacetin

tributyrin

di-(2-ethylhexyl) adipate

dioctyl phthalate (DOP)

di-isooctyl phthalate (DIOP)

Eastman plasticizers

As a leading supplier of quality plasticizers, Eastman is pleased to announce the addition of di-isooctyl phthalate to its line. Manufactured from a new, improved type of isooctyl alcohol, this plasticizer possesses the excellent qualities for which the present Eastman plasticizers are noted. It is available in drum, tank truck and tank car quantities. DIOP is only one of the many fine plasticizers made by Eastman. For further information on any of the plasticizers listed above, write or call your nearest Eastman representative.

Eastman
CHEMICAL PRODUCTS, INC.,
KINGSPORT, TENNESSEE
subsidiary of EASTMAN KODAK COMPANY

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tenn.; New York—260 Madison Ave.; Framingham, Mass.—65 Concord St.; Cincinnati—Carew Tower; Cleveland—Terminal Tower Bldg.; Chicago—360 Michigan Ave.; Houston—412 Main St.; St. Louis—Continental Bldg. **West Coast: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Salt Lake City—73 S. Main St.; Seattle—821 Second Ave.

They'll come out

EASIER CLEANER FASTER

if you use METASAP® STEARATES

***M**olders who know* use Metasap Zinc or Calcium Stearates... they find them the surest, safest way to eliminate disintegration and breakage of finished products.

Further, you can add these Stearates in two ways. You can incorporate them into the molding compound... or simply dust them onto the mold surface. Either way, you'll find this improved lubrication *minimizes ejection pressures.* You'll increase your output, get fewer rejects, better products. Your molds last longer, too.

So specify compounds containing Metasap Stearates, or incorporate them directly into your own molding compound. Metasap Technical Service is prepared to help you find the materials and mixing procedures best fitted to your production methods.

EXCELLENT THICKENERS FOR PLASTISOLS

Metasap also offers a complete line of quality Stearates, effective as thickening agents. We'll be glad to make available to you free testing samples of Magnesium, Barium, Calcium, or Aluminum Stearates. Ask for yours today.

METASAP CHEMICAL COMPANY

METASAP CHEMICAL COMPANY
HARRISON, NEW JERSEY
Chicago, Ill. • Boston, Mass.
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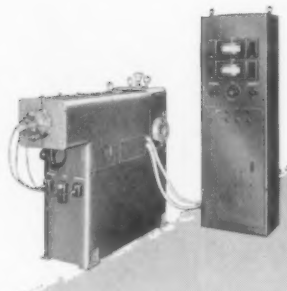
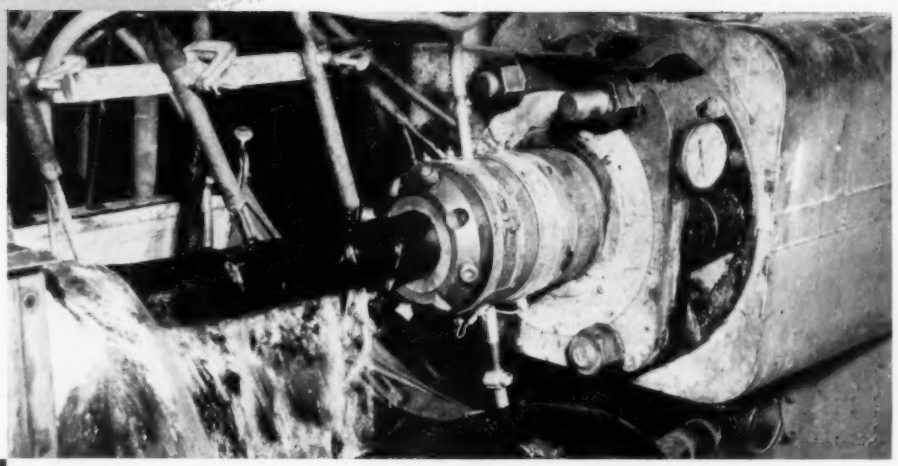
a NOPCO subsidiary

the cleanest stearates made



WHY YARDLEY'S NEXT PLASTICS EXTRUDER WILL BE . . .

Another NRM



Company President F. B. Hill, Jr., (left) and C. A. Ebner, examine a sample of ribbed plastic pipe from the firm's first NRM Extruder. The machine is a 2½" oil-heated unit. Its production in the last ten years is well over a million and a half pounds of extruded plastics.

When asked why Yardley has always bought NRM Extruders, C. A. Ebner, Executive Vice President, replied: "We think NRM's design and engineering have always led the field, and production records of our machines bear us out. That's why we are 100% NRM."

The Yardley Company extrudes rigid and flexible pipe to exacting dimensions for mines, factories and water wells. Other specialties are parts for vacuum cleaners and gasketing for general sealing purposes. Many of their extruded shapes must meet rigid tolerances for fabricating into other precision-made products.

Today, in its three plants (two in Columbus, and one in Chatham, Ont., Canada) the Yardley Company operates 12 NRM Extruders, and accounts for 2,225,000 pounds of extruded plastics annually.

In less than a dozen years, Yardley Plastics Company, Columbus, Ohio, has grown from a small extrusions manufacturer with one NRM Extruder, to rank among the Nation's top extruded plastics producers.

The attitude of Yardley Plastics is typical of the feeling NRM owners the world over have about NRM Extruders. If you're planning to purchase thermoplastic extrusion equipment, look into the NRM line today. A postcard brings you full information and data, promptly, without obligation.

2096

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NRM

Creative Engineering

General Offices & Engineering Laboratories: Akron 8, Ohio

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Export: Omni Products Corporation, 460 Fourth Ave., New York 16, N. Y.

does cold weather do strange things to your plastics?

then give your product low-temperature flexibility with Plastolein® 9058 DOZ!

If plastic products made from your film, sheeting or extrusions become stiff and wrinkled in cold weather, you may be freezing up a lot of reorders. Then getting better low temperature flexibility is the answer. And no plasticizer can provide this better than Plastolein 9058 DOZ (di-2-ethylhexyl azelate) or its companion, Plastolein 9057 DIOZ (di-iso-octyl azelate).

Not only do these azelate plasticizers provide unexcelled low-temperature performance, but they also possess low volatility, excellent heat and light stability, high efficiency, low water extraction, and extremely low soapy water extraction...all of which make these Plastolein Azelates the best all around low-temperature plasticizers available.

So, why not try Plastoleins 9058 DOZ or 9057 DIOZ in your product. The competitive advantages they give will mean greater consumer acceptance... greater sales to you. Write Dept. F5 for literature or samples.

Be sure your plastics stay plastic . . . use Plastolein Plasticizers every time

Emery

Fatty Acids & Derivatives
Plastolein Plasticizers
Twitchell Oils, Emulsifiers

Emery Industries, Inc., Carew Tower, Cincinnati 2, Ohio

New York; Philadelphia; Lowell, Mass.; Chicago; San Francisco; Cleveland
Warehouse stocks also in St. Louis, Buffalo, Baltimore and Los Angeles • *Export: 5035 RCA Bldg., New York 20, New York*

Now Puerto Rico Offers 100% Tax Exemption to New Industry

by BEARDSLEY RUML

"We don't want runaway industries" says Governor Muñoz. "But we do seek new and expanding industries." Federal taxes do not apply in Puerto Rico, and the Commonwealth also offers full exemption from local taxes. That is why 300 new plants have been located in Puerto Rico, protected by all the guarantees of the U. S. Constitution.

Beardsley Ruml

IN A dramatic bid to raise the standard of living in Puerto Rico, the Commonwealth Government is now offering U. S. manufacturers such overwhelming incentives that more than three hundred new factories have already been established in this sun-drenched island 961 miles off the Florida coast.

First and most compelling incentive is a completely tax-free period of ten years for most manufacturers who set up new plants in Puerto Rico.

For example, if your company is now making a net profit after taxes of $53,500, your net profit in Puerto Rico would be $100,000—a gain of 87 per cent as a result of non-applicability of U. S. Corporate Income Tax in Puerto Rico.

Your dividends in Puerto Rico from a corporation there could be $50,000 against $25,000 net in the U. S.—owing to the non-applicability of the U. S. Income Tax.

What About Labor?

Puerto Rico's labor reservoir of 650,000 men and women has developed remarkable levels of productivity and efficiency—thanks, in part, to the Commonwealth's vocational training schools. These schools also offer special courses for managers and supervisors.

The progress made in technical skills may be gauged from the fact that there are now twenty-eight factories producing delicate electronic equipment.

Among the U. S. companies that have already set up manufacturing operations in Puerto Rico are Sylvania Electric, Carborundum Company, St. Regis Paper, Remington Rand, Univis Lens, Shoe Corporation of America, and Weston Electric.

CORPORATE TAX EXEMPTION

If your net profit after U. S. Corporate Income Tax is:	Your net profit in Puerto Rico would be:
$ 17,500	$ 25,000
29,500	50,000
53,500	100,000
245,500	500,000
485,500	1,000,000

DIVIDEND TAX EXEMPTION

If your income* after U. S. Individual Income Tax is:	Your net income in Puerto Rico would be:
$ 3,900	$ 5,000
7,360	10,000
10,270	15,000
14,850	25,000
23,180	50,000
32,680	100,000
43,180	200,000
70,180	500,000

*These examples are figured for dividends paid in Puerto Rico to a single resident. Based on Federal rates effective Jan. 1, 1954.

"Close to Paradise"

Listen to what L. H. Christensen, Vice President of St. Regis Paper, says:

"The climate is probably as close to paradise as man will ever see. I find Puerto Ricans in general extremely friendly, courteous and cooperative.

"This plant in Puerto Rico is one of our most efficient operations, in both quality and output. Our labor has responded well to all situations."

Mr. Christensen might have added that the temperature usually stays in the balmy 70's twelve months a year.

The swimming, sailing and fishing are out of this world. Your wife will rejoice to hear that domestic help is abundant.

The Commonwealth will leave no stone unturned to help you get started. It will build a factory for you. It will help you secure long-term financing. It will even screen job applicants for you—and then train them to operate your machines.

Transportation

Six steamship companies and four airlines operate regular services between Puerto Rico and the mainland. San Juan is just 5½ hours by air from New York.

Light-weight articles such as radar components come off the line in Puerto Rico one day and are delivered by air freight next day in Los Angeles, Chicago and other mainland cities. And, of course, there is no duty of any kind on trade with the mainland.

Are You Eligible?

Says Governor Muñoz: *Our drive is for new capital. Our slogan is not "move something old to Puerto Rico," but "start something new in Puerto Rico" or "expand in Puerto Rico."*

The Commonwealth is interested in attracting all suitable industries, and especially electronics, men's and women's apparel, knitwear, shoes and leather, plastics, optical products, costume jewelry, small electrical appliances, hard candy and pharmaceuticals.

To get all the facts, and to find out whether you and your company would be eligible for complete tax exemption, mail the coupon below.

MAIL THIS COUPON

Economic Development Administration
Commonwealth of Puerto Rico, Dept. P-3
579 Fifth Avenue, New York 17, N. Y.

Mail me "Facts for Businessmen," your report of the advantages of Puerto Rico for plant location.

Name_____

Company_____

Product_____

Address_____

BUY from GERING

AND Save!

VIRGIN AND RE-PROCESSED POLYETHYLENE

Now more readily

AVAILABLE!

Call on GERING . . . to supply various color Molding Powders for immediate and future needs . . . .

Phone - Write - Wire - - Cable address, GERING

GERING *Products • Inc.*
KENILWORTH, N. J.

SAVE $ SAVE $ SAVE $

HITCH YOUR PRODUCTION TO A NEW STAR . . .

FULLY AUTOMATIC PRODUCTION NOW IS POSSIBLE WITH THE IMPROVED LEWIS "4". New and extremely sensitive low-pressure closing controls provide absolute safety for molds and operators . . . permit "hands off" production. These new controls feature infinitely variable adjustment and allow machine to close at normal speed with very low hydraulic pressure. If no obstruction is encountered when the moving platen reaches pre-set point, final high-pressure close is effected instantly and automatically. When moving platen meets slightest resistance in closing, the machine stops immediately and activates a warning bell and light.

The LEWIS "4" handles almost any plastics material . . . will mold intricate 2 to 3-ounce large area parts originally produced on 8-ounce equipment. Small and sturdily constructed, Model "4" provides multiple shot injection and fast operation for high production with minimum scrap and maintenance.

Write for BULLETIN 101 for additional details.

3071-LW

THE LEWIS "4" INJECTION MOLDING MACHINE

LEWIS

THE LEWIS WELDING & ENGINEERING CORPORATION
11 INTERSTATE STREET • BEDFORD, OHIO

guides to good design in Plexiglas

Here are the two basic design manuals on PLEXIGLAS molding powders and sheets. They are detailed presentations, fully diagrammed and illustrated, showing the best ways to make use of this Rohm & Haas Company acrylic plastic.

Molding Powder Product Design discusses principles of optical design, decorative effects, and methods of attaching molded PLEXIGLAS parts.

Design and Fabrication Data covers the fabricating techniques and design considerations for making products from PLEXIGLAS sheets.

Strength, beauty, dimensional stability, resistance to weather and breakage—these are some of the properties that make PLEXIGLAS a preferred material for scores of industrial and commercial products. The brochures shown above have been prepared to help product designers and engineers use these properties to best advantage. To obtain your copies promptly, just use the coupon below. In addition, we will be glad to advise you on how a specific design problem may be solved with PLEXIGLAS.

ROHM & HAAS COMPANY
Washington Square, Philadelphia 5, Pa.

Please send me:

☐ **"Molding Powder Product Design".**
☐ **"Design and Fabrication Data".**

Name.....
Company.....
Address.....
City.....*Zone*.....*State*.....

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another important advantage

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DRAPEX 3.2

LOW TEMPERATURE EPOXY PLASTICIZER

provides LOW SOAPY WATER EXTRACTION

The chart on the right shows the results of tests conducted to compare the soapy water extraction of Drapex 3.2 with other plasticizers. Equal size samples of the various materials were laundered in a small washing machine for ½ hour in a ½% Ivory Soap solution, at a water temperature of 150° F. The samples were spun dry, rinsed in fresh water for 10 minutes at 150° F. They were then dried in an air circulating oven at 212° F. Assuming that all losses are plasticizer losses, the chart reveals the important advantage of Drapex 3.2.

In addition, the low temperature flexibility of Drapex 3.2 is superior to DOA. Its lower specific gravity is combined with a low volatility.

The epoxy content of Drapex 3.2 provides excellent stability, high heat resistance, and good weathering characteristics. All of these advantages help you make better, longer lasting vinyls at lowest cost. Make your own test and see. Write today for Technical Bulletin 4 and a generous working sample.

SOAPY WATER EXTRACTIONS (½% Ivory Soap Solution @ 150° F.)

COMPOUNDS TESTED					
Resin	100.0	100.0	100.0	100.0	100.0
Dioctyl Phthalate	45.0	30.0	30.0	30.0	30.0
Dioctyl Sebacate	—	15.0	—	—	—
Dioctyl Adipate	—	—	15.0	—	—
Butyl Epoxy Stearate	—	—	—	15.0	—
▶ DRAPEX 3.2	—	—	—	—	15.0
Per Cent of Total Plasticizer Lost					
5 Laundering Cycles	3.9%	2.3%	6.9%	12.7%	2.6%
6 Laundering Cycles	4.9%	3.1%	8.7%	14.6%	3.5%
7 Laundering Cycles	6.0%	4.2%	10.3%	16.5%	4.4%
8 Laundering Cycles	6.6%	4.7%	11.4%	17.9%	5.1%
9 Laundering Cycles	8.5%	5.7%	13.8%	19.8%	6.1%
10 Laundering Cycles	9.3%	6.5%	14.7%	20.4%	**6.8%**

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"Dutch Boy" team makes it easy to build in low temperature flexibility.

How to team up "Dutch Boy" Plasticizers and Stabilizers to

Improve Quality and Cost Control in Vinyl Profile Extrusions

With *this* "Dutch Boy" team, you can develop highly serviceable and low-cost compounds for garden hose, shoe and automotive welting, refrigerator gasketing, industrial belting and tubing, aircraft multiple tubing and similar products.

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Use "Dutch Boy" NL F-21 to cut system volatility down to size. It aids economy without sacrificing stability or low temperature flexibility.

Use "Dutch Boy" NL F-31 to build up low temperature flexibility. It adds permanence, weather resistance and low water extraction, too.

Use "Dutch Boy" NL A-54 to develop maximum economy. It gives a good balance of low volatility and low temperature flexibility.

The combination gives you exceptionally efficient plasticizing action and promotes compatability. Light stability, too.

Back up the compounds with four "Dutch Boy" Stabilizers

To establish high heat stability in these extrusion formulations, use *"Dutch Boy" Dyphos or Tribase* for opaque stocks, *"Dutch Boy" Clarite* for "clears." *Tribase* insures best heat stability. Dyphos gives outstanding resistance to weather and sunlight. Use "Dutch Boy" DS-207 together with Tribase and Dyphos for best results. *Clarite* gives you excellent light as well as heat stabilization. It also provides useful lubrication.

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Call on National Lead's technical staff. They'll be glad to suggest successful formulations that can be made with this "Dutch Boy" team . . . and advise you on incorporation methods.

Ask them to tell you about other useful "Dutch Boy" Plasticizer-Stabilizer combinations . . . for vinyl film and sheeting, electrical insulations, plastisols, many others. Or write for our condensed 12-page catalog, " 'Dutch Boy' Chemicals."

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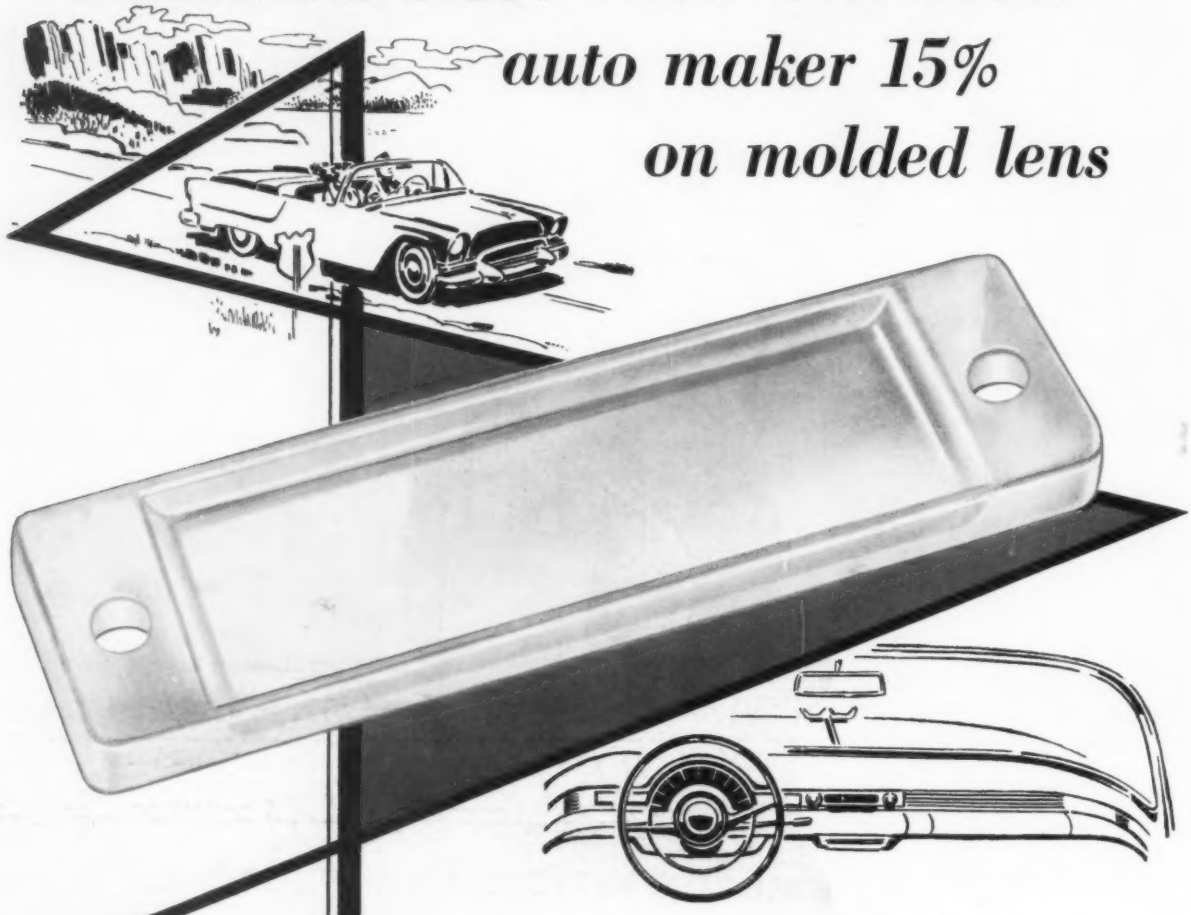
RICHARDSON *know-how saves auto maker 15% on molded lens*



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A well-known auto manufacturer required a clear acrylic molded lens for a dashboard map light. Richardson received the order, made the mold, and was ready to produce large quantities. At this point, the motor company changed the specifications to call for a translucent instead of a clear lens. To make this change, the customer suggested that Richardson sandblast the mold or sandblast the clear acrylic parts. Either process would have added to the cost of the lens.

Richardson engineers, with a wide background of experience and knowledge covering many different molding methods and materials, suggested instead a special light-diffusing polystyrene suitable for the application.

Lenses made of this material gave the desired lighting effect, and because of lower raw material cost, the customer received the improved lens at a saving of 15%.

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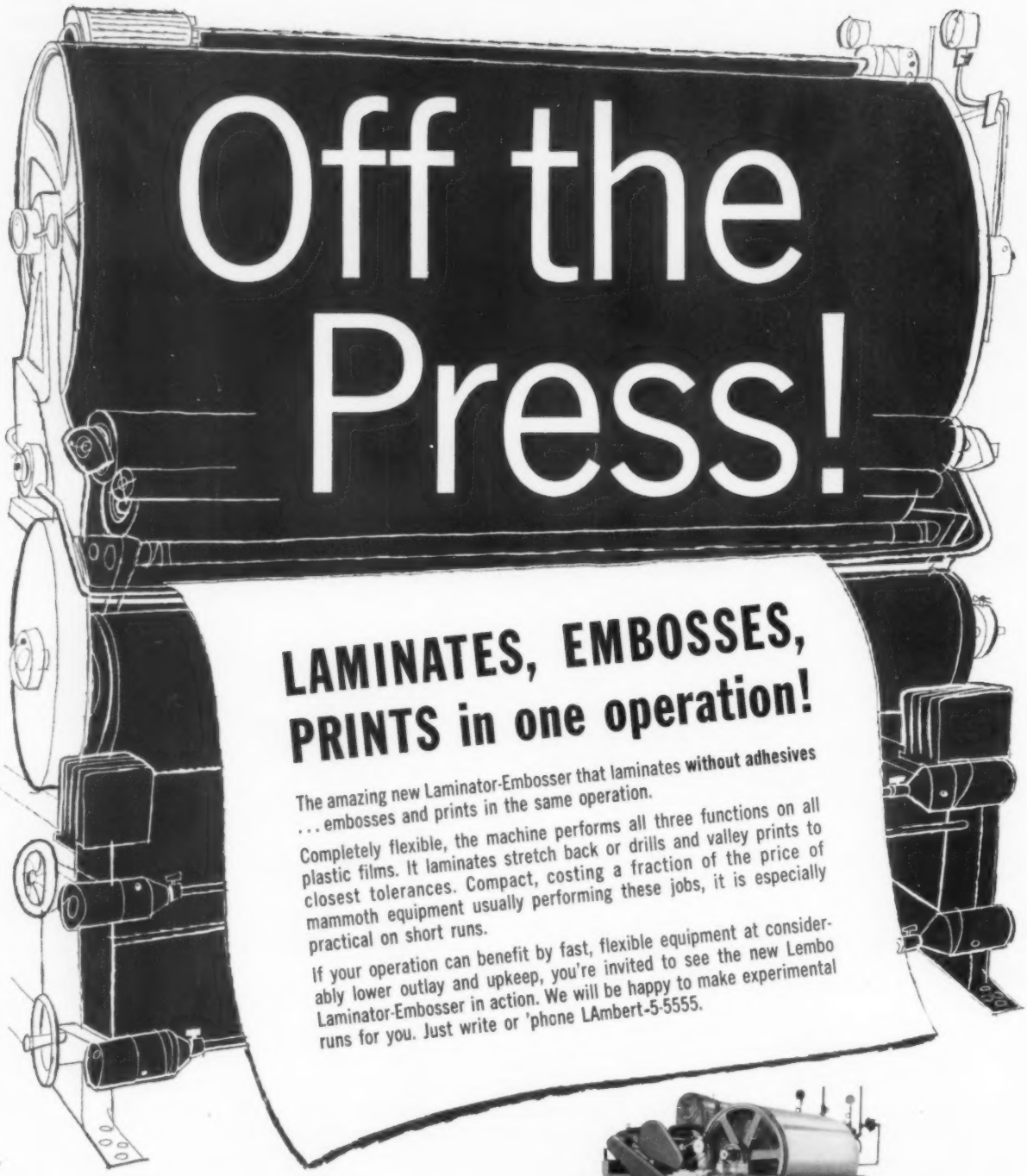

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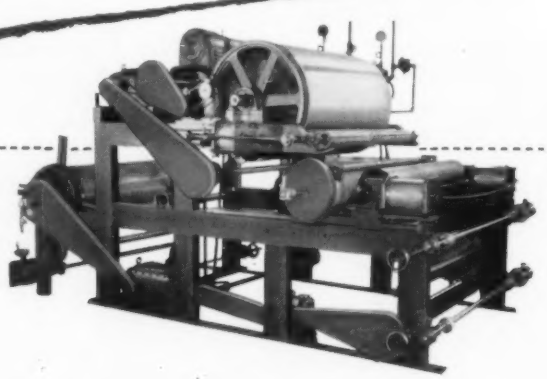

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Leading heat and light stabilizer for clear or opaque stock, an organic liquid complex containing no disadvantageous soapy component. Unequalled for stabilizing against effects of sunlight or outdoor aging.

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Leading combination of coprecipitated laurates for outstanding performance, where lubricating advantages are required. Generally 30% more effective than common barium-cadmium laurates.

Write for a Vinyl Stabilizer Check List that you may use to detail as much as possible your particular requirements.

A practical stabilizing system will be suggested promptly, based on our experience with the various Vinyl Polymers and Copolymers and with the different Plasticizers, for your processing and product end-use requirements.

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Compatible barium compound, minimum effect on viscosity. Permits processing at higher temperatures.

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Chelating agent, more than two times as effective as common organic phosphites. Inactivates harmful by-products to boost stability. Contributes to top clarity.

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Epoxy assistant, highly effective HCl scrubbing agent, undiluted. Will extend stability for longer processing periods.

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BA-CD 12-V-5: Coprecipitated laurate.
CADMIUM 22-V-1: For rigid, clear and opaque stocks.
ORGANIC 7-V-1: Epoxy assistant.
ORGANIC 7-V-4: Epoxy assistant, for rigids.
BARIUM 1-V-3: Dispersible stearate, to contribute lubricity with barium effects.
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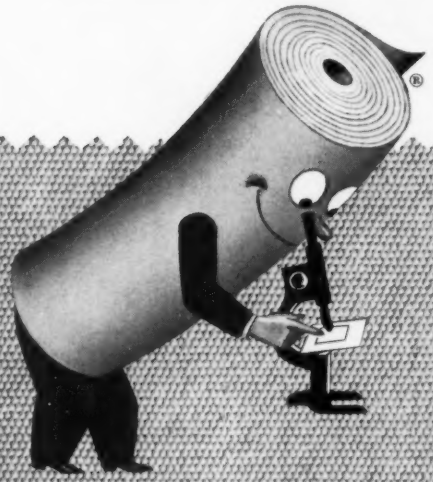

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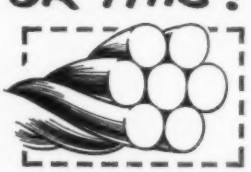

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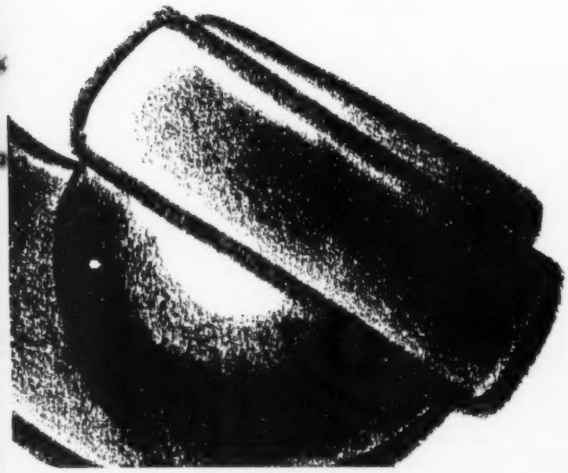

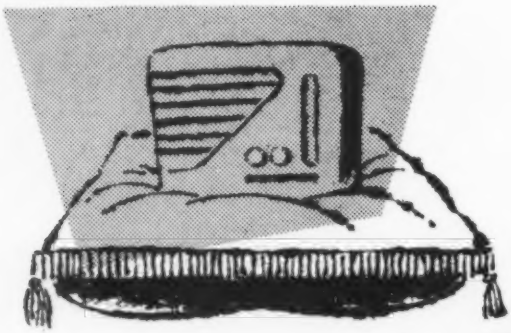

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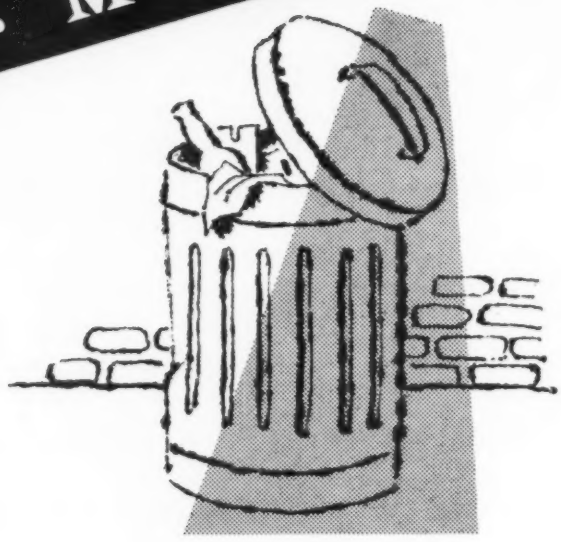

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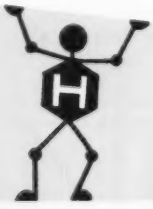

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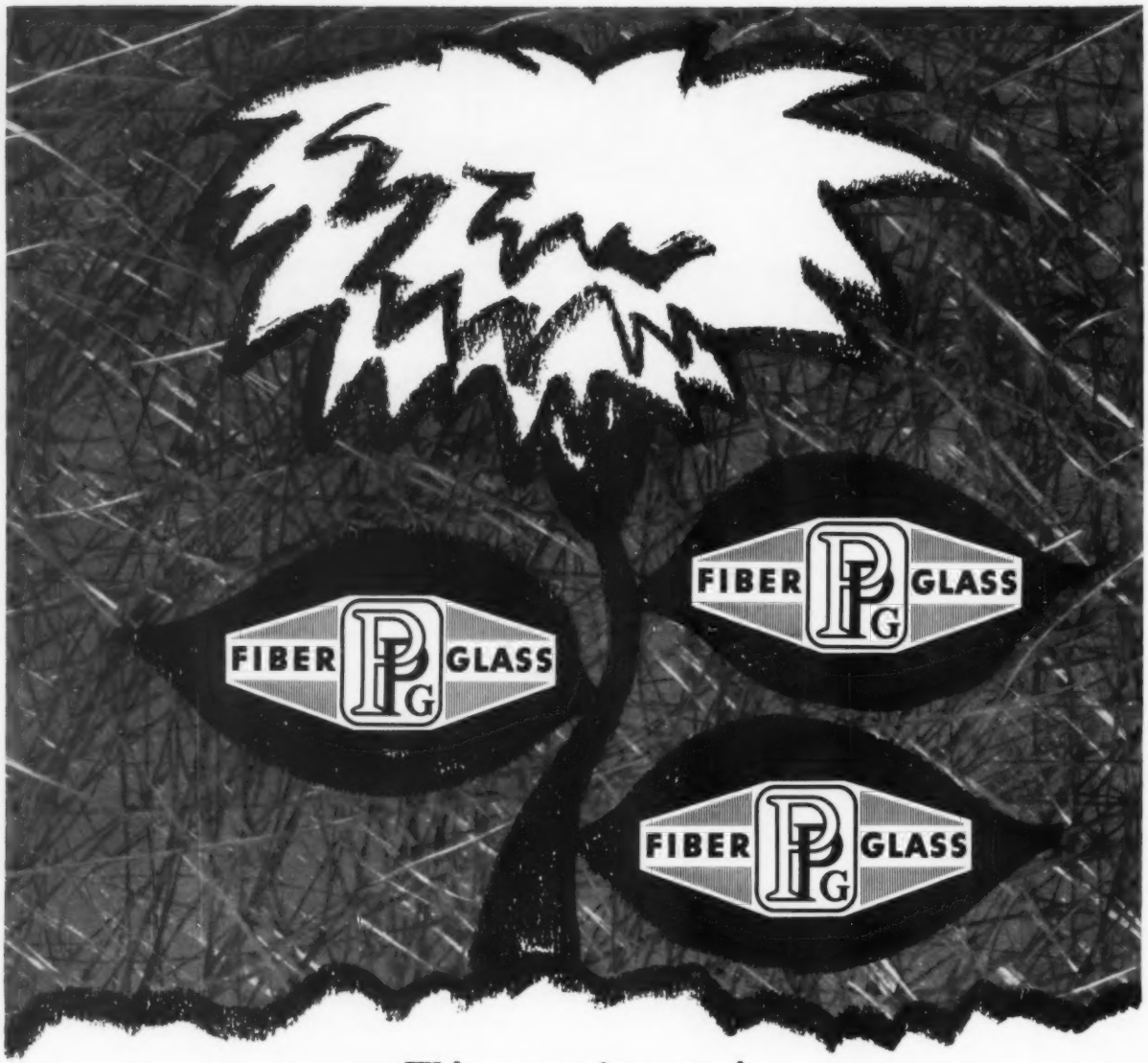

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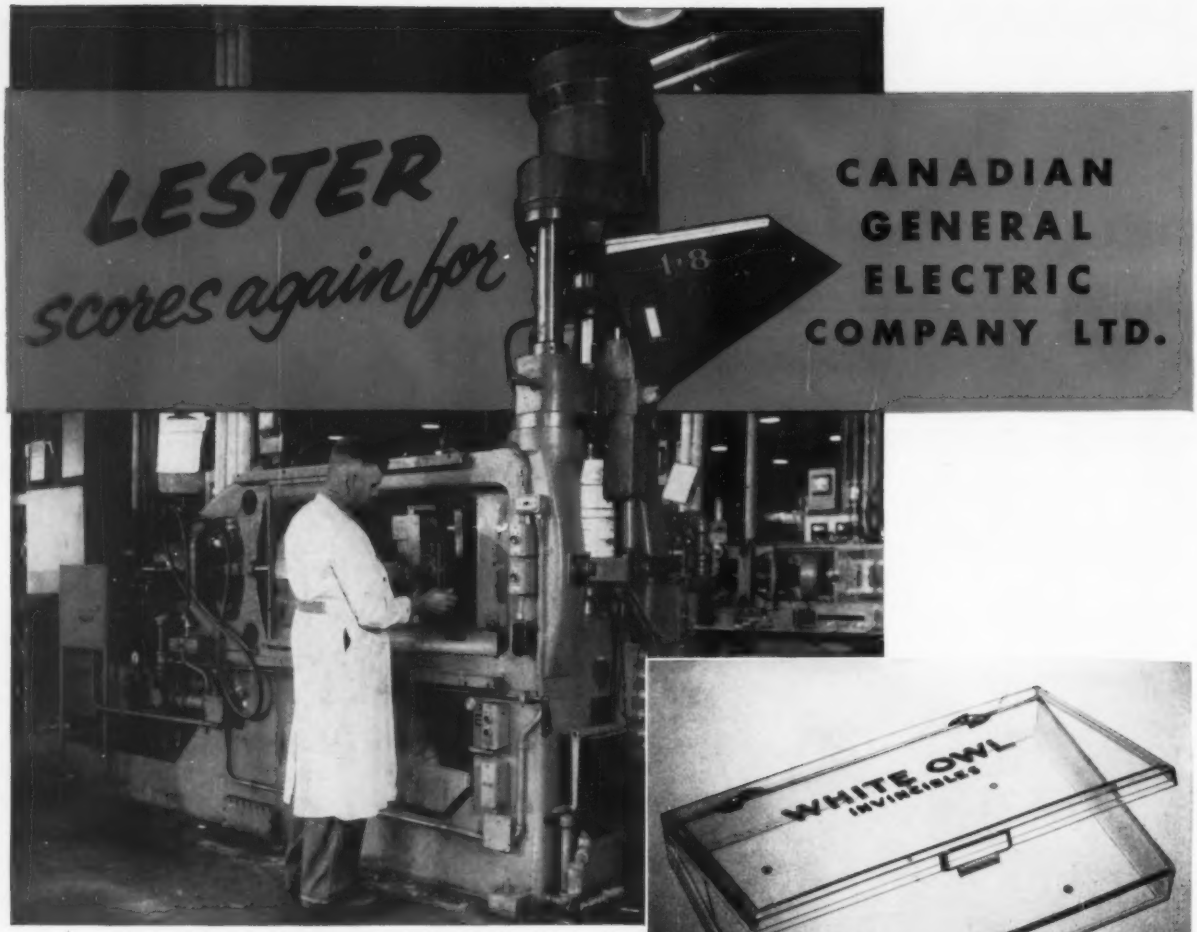

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MODERN PLASTICS

MAY 1955 VOLUME 32 NUMBER 9

PERSONNEL SAFETY -THROUGH PLASTICS

Against impact, gases, liquids, electricity, and radiation many plastics materials are used to provide protection

Courtesy Brookhaven National Laboratory

Wearing protective vinyl hood and a mask with an acetate face piece, operator is about to spray strippable vinyl film onto concrete interior walls of "hot" cell **(see p. 77)**

SOME 15,000 deaths and 2 million disabling injuries during 1953 were directly attributed to industrial work accidents in the United States (excluding all motor vehicle accidents); property destroyed and production time lost due to these accidents had a vaue of $1½ billion during this same period.* These figures, while appalling, show a decrease from the 1952 totals; it is expected that 1954 will be even better. And much of this improvement can be attributed directly to increasingly wider use of safety devices in many areas of industrial activity, both new and improved.

Because of their broad range of properties, practically all basic plastics materials play some part in the construction of the variety of devices now available for protection of personnel under all conceivable working conditions. For example, vinyl, polyethylene, acrylic, phenolic, acetate, butyrate, CR-39, and nylon are used in various ways in safety goggles and face masks designed mainly for eye protection. If all workers on jobs involving eye hazards had worn adequate eye protection devices, the appalling 1953 total of 80,000 disabling eye injuries that was recorded would have been materially reduced if not practically eliminated.

* Figures from The National Safety Council.

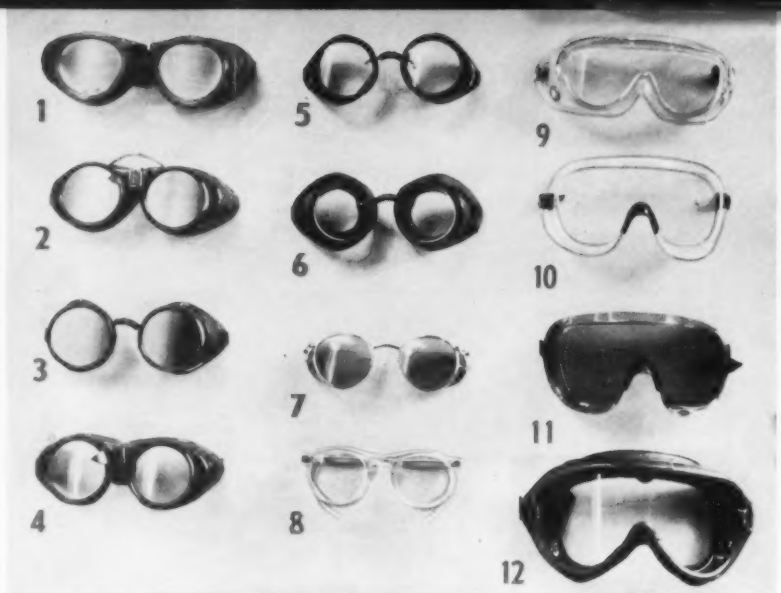
Variety of Hazards

Industrial safety has many ramifications. Workers are exposed to a variety of hazards ranging from large and small flying objects through contact with irritating gases and liquids to electrical shock and

the as not yet fully explored dangers of working with nuclear radiation.

To all these fields plastics bring impact resistance with or without transparency as desired, chemical inertness, electrical insulation, and protection in various ways against radiation effects. Any attempt to list all of the applications of plastics in safety devices and equipment would result in a catalog many times larger than this issue of MODERN PLASTICS. One manufacturer alone offers 5000 different safety helmet combinations for protection of workers against practically any impact hazard imaginable. And into these helmets and their suspensions go such a variety of plastics as phenolic-fabric laminate, polyester-glass laminate, ethyl cellulose, general purpose phenolic, cellulose acetate and butyrate, vinyl, and nylon.

However, a cross-section of plastics at work in industrial safety can be given by a descriptive sampling of five more or less arbitrary categories of devices, equipment, and instruments designed specifically to keep industrial personnel safe at work. These categories include protection against impact, whether from particles thrown off by an abrasive wheel or from a falling wrench; protection against hazardous atmospheric conditions; protection against splashed or spilled corrosive liquids; protection against electrical shock; and protection against nuclear radiation.



Courtesy Bakelite Co.

Fig. 1—Variety of goggles and spectacles for protective use against range of industrial hazards. Text below, keyed to numbers in photo, describes their specific applications

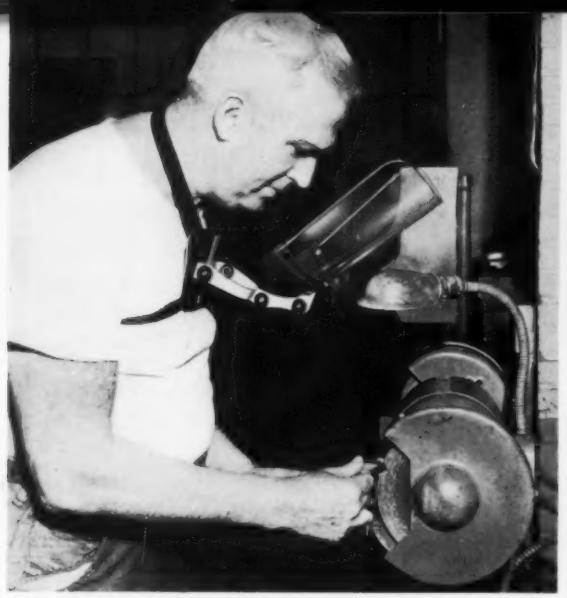
Impact Protection

Since eye injuries are so high on the annual toll list, it is natural that much attention has been given to protective goggles, spectacles, and shields. Many different designs are required because of the multiplicity of hazards to which a worker's eyes may be exposed; these include flying particles, splashing liquids, dazzling flames, and noxious fumes. The diversity of design is exemplified in Fig. 1, above, which shows 12 different goggles and spectacles, each of which provides protection against a specific industrial danger.

The following description of these eye protective devices is keyed directly to the illustration. Model 1,

Fig. 5—Flexible vinyl hood with rigid vinyl face piece shields against paint vapors

Fig. 4—Combination dust hood and respirator for eye, face, and neck protection



Courtesy Mine Safety Appliances Co.

Fig. 2—Chest-mounted shield affords good protection without being too confining; different visors can be used to suit the hazard

Courtesy Bakelite Co.

Fig. 3—Transparent acetate shield protects eyes against damage from flying particles when blowing flash from press with high-pressure air

designed for use over wide-frame prescription glasses, is becoming increasingly popular with welding operations. It can be adapted as an impact goggle by the simple expedient of removing the dark welding lenses and acetate cover plates and replacing them with clear hardened crown glass. The frame is molded of butyrate; side shields provide indirect ventilation. Model 2 is similar in construction to No. 1, with the exception of the rigid bridge support. It is a standard welding goggle with acetate cover lenses to protect the dark glass from pitting. Its frame is also molded of butyrate. Model 3 is another type of welding goggle which is most generally used in gas welding operations. It has a molded butyrate frame and the dark lenses are again protected by clear acetate cover lenses. Models 4 and 5 are used on jobs involving high-impact hazards. The frames are molded butyrate and the lenses may be either tempered glass or clear acrylic. Perforated side shields provide cross ventilation to prevent fogging.

Model 6 is an adaptation of Model 3. The molded butyrate eye cups, equipped with sponge cushions and clear acrylic or glass lenses, make this model ideal for working with chemicals.

Model 7 is used extensively by workers in the vicinity of welding operations. The shaded green lenses provide both impact and flash protection. The goggle is equipped with clear acetate side shields and adjustable nose pads fabricated of acetate. Model 8 is an acetate-frame spectacle goggle which is usually equipped with prescription plastic or glass lenses. Prescription lenses of clear acrylic or CR-39, rather than glass, are becoming increasingly popular because of their light weight.

Models 9, 10, and 11 are designed to protect the wearer from low impact and dust hazards. Model 9 has a molded vinyl frame and fabricated vinyl lenses which are replaceable. Models 10 and 11 are molded in one piece of cellulose acetate, 10 being molded in clear transparent and 11 in green transparent. The colored goggle is used chiefly as protection from excessive glare. Model 12, widely used in the chemical industry, has a replaceable acetate lens. The frame of this model is equipped with protective screen vents.

Models 1 through 6, as well as 8 and 12, are manufactured by Ameri-

Fig. 6—Protective gear worn by worker in still room of plastics material manufacturer includes laminated helmet with detachable rigid vinyl face, and goggles

Courtesy Bakelite Co.

Fig. 7—Chemical worker wears protective goggles, apron, sleeves, and gloves

Photos this page courtesy Bakelite Co.

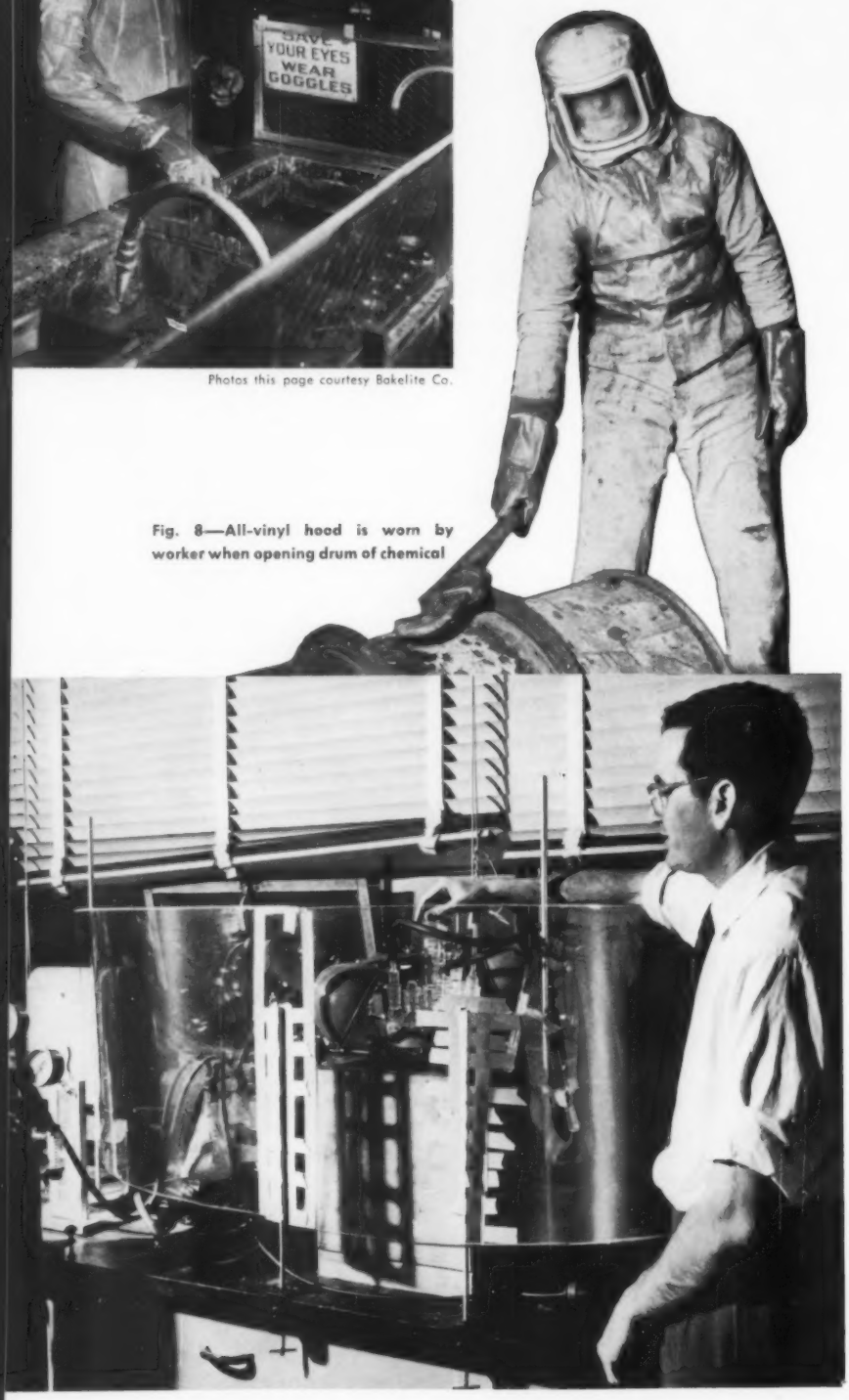


Fig. 8—All-vinyl hood is worn by worker when opening drum of chemical

Fig. 9—Specialized protective unit, fabricated of clear rigid vinyl sheet, is designed to shield operator from splashings of hazardous liquids used in experimental set-up

can Optical Co., Southbridge, Mass.; Models 7, 10, and 11 are produced by Pennsylvania Optical Co., Reading, Pa.; Model 9 is made by U. S. Safety Service, Kansas City, Mo.

Chest-Mounted Shield

To provide another form of eye and face protection, a chest-mounted shield (Fig. 2, p. 73), a product of Mine Safety Appliances Co., Pittsburgh, Pa., provides ample protection yet eliminates that "closed-in" feeling which some operators experience when wearing hoods or goggles. The replaceable, transparent visor is available in three thicknesses of cellulose acetate sheet—0.020, 0.040, and 0.060 in.—when this shield is to be used for protection against fine particles such as the abrasive from a grinding wheel. The manufacturer states that acetate was used because it has good impact and scratch resistance and is low in cost. Where the shield is to be used for protection against splashing chemicals, vinyl sheet stock is used.

In compression molding of thermosetting materials, some flash always remains in the press after the molded part has been removed. Standard procedure is to dispose of this flash by blowing it out with high-pressure air. Because there is always a chance that this operation will result in eye injury to the operator, a transparent acetate shield (Fig. 3, p. 73) has been developed which prevents such a possibility.

In Hazardous Atmospheres

There are a multitude of hoods, masks, and respirators to protect operators working in hazardous atmospheric conditions. The one shown in Fig. 4, p. 72, is a combination dust hood and respirator which provides eye, face, and neck protection against excessive dust or abrasive showers. The hood is made of acid- and caustic-resistant cloth woven of Dynel, an acrylic synthetic fiber. It is equipped with a rigid vinyl viewing lens which can be easily removed for cleaning or replacement. An important component of the respirator is an injection molded nylon fork which holds the removable filter in place. Nylon is chosen for this part, partly because of its toughness but mainly because of its superior chemical resistance.

Another hood which offers complete protection for the face, eyes,

Courtesy Lockheed Aircraft Corp.

Fig. 10—Apron molded of reinforced polyester keeps flying metal particles, thrown off during high-speed milling operations, from harming operator

Courtesy Willson Products, Inc.

Fig. 11—Industrial helmet is molded of glass-reinforced plastics, has geodesic suspension and pneumatic head band cushion

and neck against light concentrations of irritating vapor, encountered during painting and spraying operations, is shown in Fig. 5, p. 72. The hood is made of flexible vinyl and has a rigid vinyl face piece which offers a wide range of vision. An auxiliary, replaceable vinyl lens covers and protects the integral face piece from pitting and spattering. Thus, because the replaceable lens takes the beating instead of the integral lens, it is not necessary to throw away the entire hood because of a disfigured face piece.

In one of the still rooms of a large plastics material manufacturer, the head and face protective gear shown in Fig. 6, p. 73, must be worn by workers. It includes a high-pressure laminated helmet to which is attached a removable rigid vinyl face shield, plus a pair of goggles shown as Model 6 in Fig. 1. In the chemical laboratories of this same company, workers must wear safety goggles (Model 12, Fig. 1), a flexible vinyl apron and sleeves, and neoprene gloves. (See Fig. 7, on opposite page.) In this same plant workers opening drums of chemicals are required to wear an all-vinyl hood such as shown in Fig. 8.

Although several of the previously described goggles and hoods afford adequate protection against splashed or spilled liquids, it is sometimes necessary to design and fabricate specialized protective units for which no standard equipment is available. Figure 9 illustrates a case in which workers with an experimental setup involving dangerous liquids had to be protected from possible splashing. Clear rigid vinyl sheet was used for the protective shield to afford workers a complete view of the experiment at all times, yet provide the necessary protection required.

Body Protection

For protection against flying metal particles that may be thrown from high-speed milling and other types of metal working machines, a special shield-like apron (Fig. 10, above) has been devised. It is molded of fibrous glass cloth and polyester resin, the resin content being 25 percent. Although this protective apron weighs less than 3 lb. and is only ⅛ in. thick, it is capable of stopping a .38 caliber bullet fired from a distance of only 8 feet. Because of the low resin content of the laminate, the glass cloth layers separate under the impact of the bullet, thereby cushioning the shock and holding the projectile. These aprons were developed by safety engineers at Lockheed Aircraft Corp., Burbank, Calif., and molded by B. F. McDonald Co., Los Angeles, Calif.

The protective "hard hat" was previously mentioned as available in thousands of different style and design combinations and made of many different materials. One of the latest to become available (Fig. 11, above) has a molded fibrous glass-reinforced plastics shell and is equipped with a geodesic suspension and pneumatic head band cushion developed by the Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., for Willson Products, Inc., Reading, Pa. The head band cushion consists of a series of 12 vinyl air cells located between the sweat band and the shell of the hat, its function being to resist and distribute the impact of blows. Absorption and distribution of the impact is accomplished by small orifices between the air cells. Such a suspension was adopted because, even when the shell of a protective hat is not penetrated by a flying object, the brain may sustain serious and permanent injury unless such a suspension intervenes.

Protection from Electricity

Up until about two years ago, linemen for electric power and lighting companies did not wear head gear which would protect them if they should come in contact with live

Courtesy Mine Safety Appliances Co.

Figs. 12 through 14—Molded thermoset helmet (left), designed for linemen, has web-type suspension held by molded ethyl cellulose clips (below)

wires. Recently, Mine Safety Appliances Co. developed and now has on the market a specialized helmet (Fig. 12, above) for this use. Each molded shell is tested for safety at 10,000 volts, and has high impact strength over a broad range of temperatures. The helmet is compression molded of a thermoplastic especially developed for this application, the composition of which is held confidential by the manufacturer. The outer shell of this helmet is shown in Fig. 13; Fig. 14 shows the inside suspension. Mounting clips for the web-type suspension are injection molded of ethyl cellulose, chosen for its high strength at low temperatures. According to the manufacturer, the sale of these helmets has been much greater than anticipated; the helmet has become the identifying badge of a careful lineman.

Another safety device new to the electrical field (Fig. 15, right) is used to check potential in supposedly dead power lines. Fabricated almost entirely of Grade X, 1¼ in. O.D. laminated tubing, this device detects line voltage by means of a small gas-filled tube which glows brightly upon contact with a.c. voltages. The dielectric of the laminated tubing is so dependable that the manufacturer states the unit may be used to check power lines carrying up to 500,000 volts.

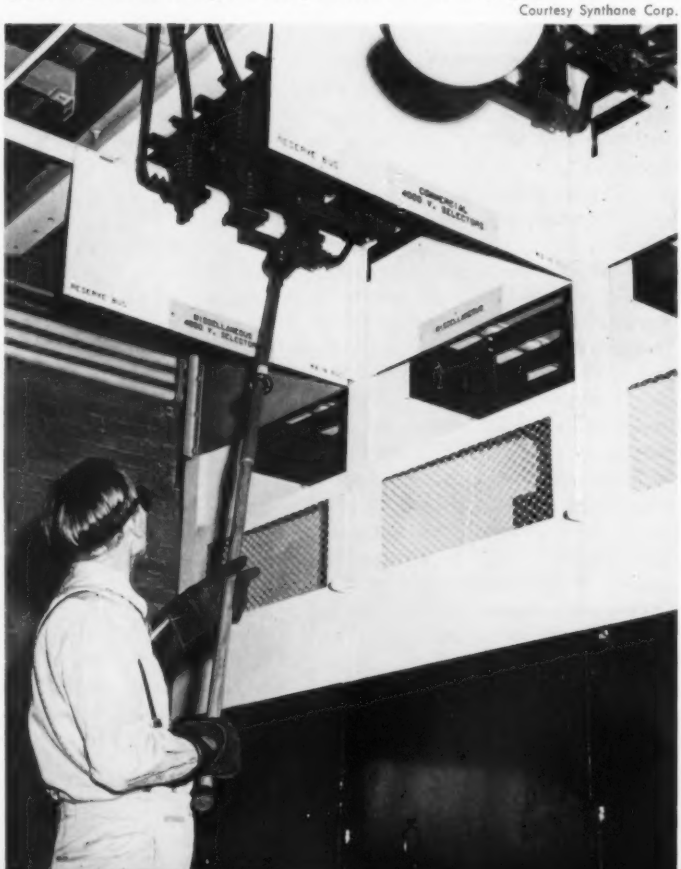
Electricity can be a hazard to human beings in more ways than simply through shock. Thus, sparks produced by electrostatic discharges in areas where explosive gases are present have always been a major problem in hospital operating rooms. When such a combination produces an explosion, the victim is generally the patient. This problem, it now appears, can be effectively solved through the use of a conductive vinyl floor tile. Manufactured by Vinyl Plastics Inc., Sheboygan, Wis., it is stated that this tile, when properly laid and grounded, will have uniform conductive characteristics over the entire floor area. In Fig. 16, right, the electrical resistance is being checked on an installation in a hospital operating room.

Protection from Radiation

Nuclear radiation, because of its insidious character, presents a form of danger against which the utmost

Fig. 15—Device to check potential of supposedly dead power lines is fabricated of Grade X laminated tubing, can safely be used on lines carrying up to 500 kilovolts

Courtesy Synthane Corp.



caution must be used. Since it cannot ordinarily be seen, heard, felt, tasted, or smelled, the problem of guarding against its adverse effects is made more difficult.

One of the problems at Brookhaven National Laboratory, Upton, L. I., that has been solved with plastics is "cleaning up" the "hot" cells in which radioisotopes are processed. The solution consists of spraying the concrete interior with a special strippable vinyl. After an experiment is completed, the now radioactive film is stripped from the walls, disposed of, and the walls resprayed with a fresh, non-radioactive coating. The photograph on p. 71 shows an operator at the door of one of the Brookhaven cells preparing to apply a fresh coating of vinyl to the interior. He is wearing a protective vinyl hood and a mask having an acetate face piece.

In another experimental set-up at Brookhaven, involving studies of the effect of radiation on plant buds, radioactive phosphorus is used as the radiation source. Here thick sheets of acrylic serve as safety shields to permit the research workers to remain in the immediate vicinity of the radiation source.

Whenever radioisotopes are used, whether it be in atomic energy plants or in research laboratories, employees must be constantly checked to make sure that they are not being subjected to overexposure from radiation. All installations use a film dosimeter in which is mounted a small sheet of photographic film. The dosimeters must be worn by employees at all times while at work. The film is changed and developed periodically and the degree of exposure is calculated. There are many different designs for the film mounting device; at Oak Ridge National Laboratory, Oak Ridge, Tenn., a combination identification badge and dosimeter (Fig. 17) is standard equipment.

This combination badge, with frame, window, filter, and case of cellulose acetate butyrate, weighs about ¾ oz. and measures 1½ by 2 3/16 in. by slightly more than ¼ in. thick. The various components are shown in Fig. 18.

Courtesy Rohm & Haas Co.

Fig. 16—Danger of operating room explosions is greatly reduced by installing conductive vinyl tile flooring, shown here being tested for electrical resistance

Another approach to the use of plastics in promoting safety in the field of nuclear radiation has been developed by Dr. G. Failla, Radiological Research Laboratory, Columbia University, New York, N. Y. This approach involves the study of the biological effects of ionizing radiation. Because it was obvious that human tissue could not be used in this study, a plastic equivalent was sought.

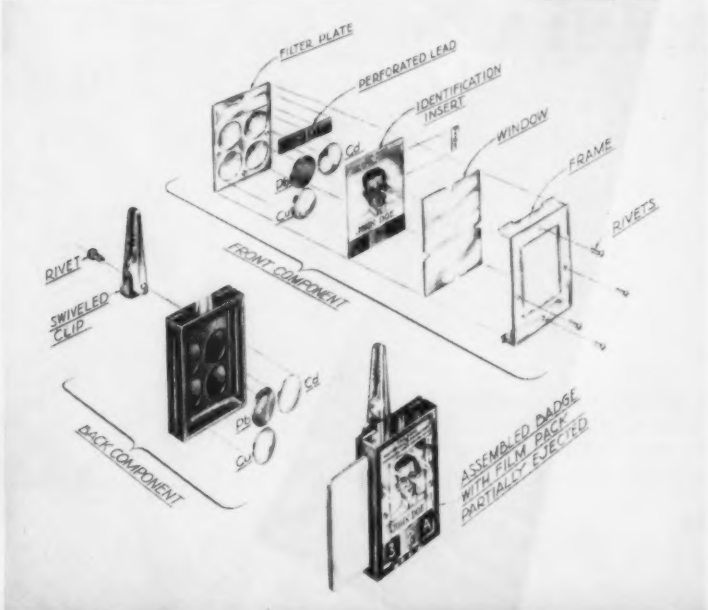
The procedure required a material which would approximate the chemical composition of the human body, which contains (by weight) on the average of 65% oxygen, 18% carbon, 10% hydrogen, 3% nitrogen,

(*To page* 198)

Fig. 17—Combination identification badge and dosimeter registers level of radioactivity

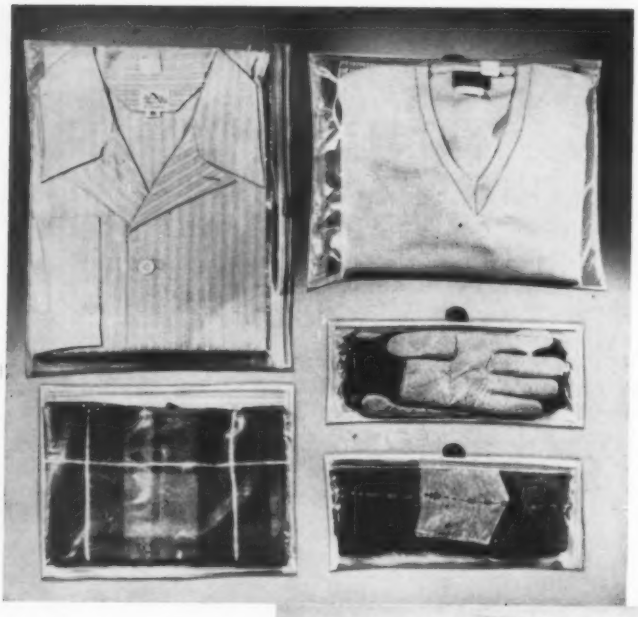
Courtesy Union Carbide and Carbon Corp.

Fig. 18—Components of dosimeter-identification badge combination. Frame, window, filter, and case are of cellulose acetate butyrate; weight is about ¾ ounce



New Uses for Plastics ZIPPERS

Vinyl and polyethylene fasteners provide dustproof, water-tight seals for new packaging and industrial applications



Photos courtesy FlexiGrip, Inc.

Vinyl slide fasteners heat-sealed to the mouths of clear vinyl film bags provide dust-proof protection for clothing

Polyethylene zippers increase re-use value of polyethylene film bags used for preserving both fresh foods and leftovers

TOOTHLESS though they be, all-plastic zippers are getting a firmer grip on more new specialized markets than many of their conventional metal counterparts.

Packaging applications, in particular, have come a long way and now, with the introduction of a polyethylene zipper to supplement the standard vinyl unit, should go even further—and faster.

Nor, according to FlexiGrip, Inc., New York, N. Y., manufacturers of the zippers, will industrial and consumer packaging provide the only outlet. Military applications are another possibility; closures for loose-leaf binder pockets, picnic bags, and various household and cosmetic kits are potential large-volume markets; and the use of the zippers in fabricating easy-to-install plastic film protective coverings is another.

Basically, the zippers consist of two identical vinyl or polyethylene runners extruded to close tolerances. Each runner has two channels and two longitudinal ribs and each rib has a sharp undercut on one side. When the two runners are forced together, the rib of one fits into the channel of the other and the undercut section locks the two opposing ribs securely together.

To force the runners together or to open them, a conventional slide made of metal can be used. In many cases, however, the zipper is designed in such a way that it can be operated by hand, without the use of slides. To open, the upper runner, which is extruded in this case with a flange, is simply lifted up with the fingers and pulled away from the lower runner; to close, the runners are pressed together so that the tracks engage.

Because of its construction, the plastic zipper overcomes many of the objections to the metal-toothed slide fastener. Since it has no teeth, it cannot jam, catch, or tear and, when closed, it provides a highly effective dustproof, water-tight, leakproof seal. It is also lighter in weight and neater looking than the conventional metal slide—and will not rust or corrode.

Packaging

One of the major advantages of the plastic zipper is the ease with which it can be automatically sealed to plastic film and sheeting.

This ability has proved especially

applicable in the packaging industry where emphasis on the use of transparent plastic film bags and coverings is strong. Unlike heat-sealed packages, a plastic bag incorporating a plastic zipper can be opened and reclosed as many times as desired. The plastic bag can thus be sold as an attractive, re-usable container that can be zipped shut around the packaged item as a protective cover when the item is not in use.

The food field also stands out as a major market for "zip-up" plastic bags — especially for polyethylene bags. When sold as stock items, such bags can be useful for preserving food in the refrigerator, in the freezer, in the lunch box, or on picnics. "Zip-up" garment bags and bags for sweaters, shirts, towels, handkerchiefs, and blankets, is another excellent market for plastics zippers. And several manufacturers of precision equipment, hardware, and toiletries are considering adapting the advantages of the plastic zipper to their own particular packaging needs.

In all of these applications, the plastic zipper can be washed with the package without fear of its becoming rusted or warped, or otherwise damaged.

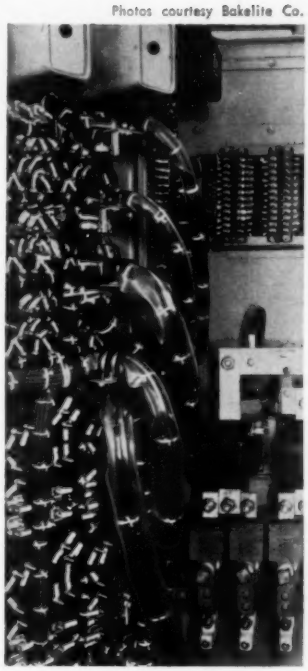
Protective Covers

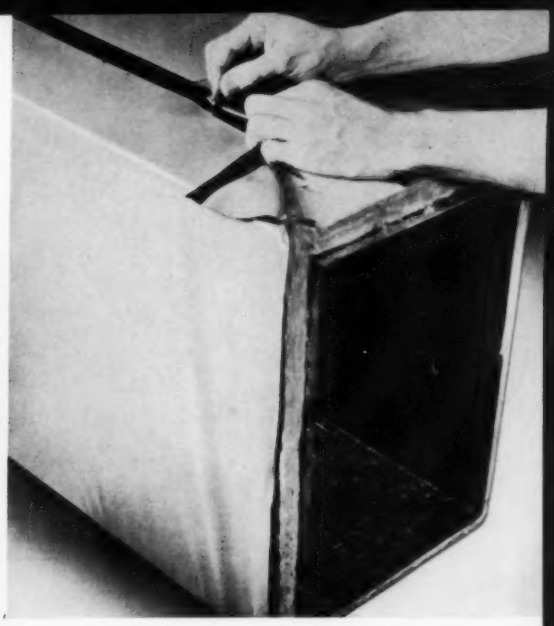
Ever since its introduction several years ago*, the plastic zipper has cropped up a number of times in specialized applications in which a plastic film has to be used as a removable protective cover. In a granery in the Mid-West, for example, the large amount of dust floating in the air affected the operation of various electrical units. To provide complete dustproof protection, and, at the same time, allow easy access

(*To page* 199)

* "Extruded Slide Fastener," MODERN PLASTICS, 29, p. 79, Sept. 1951.

Photos courtesy Bakelite Co.





Protective vinyl covering for duct is held in place by pulling vinyl zipper shut

Vinyl fasteners also simplify installation of coverings on hard-to-get-at cables

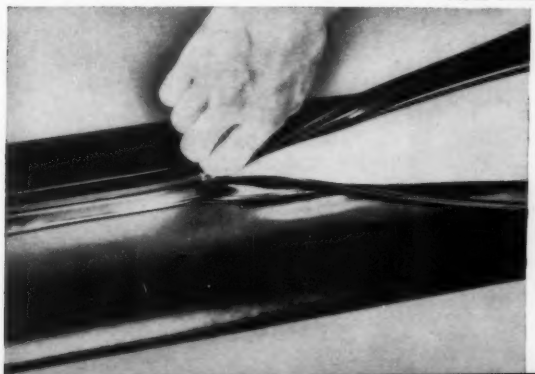
Slide fasteners are especially adaptable for use as closures on overshoes and similar garment accessories fabricated of vinyl sheeting

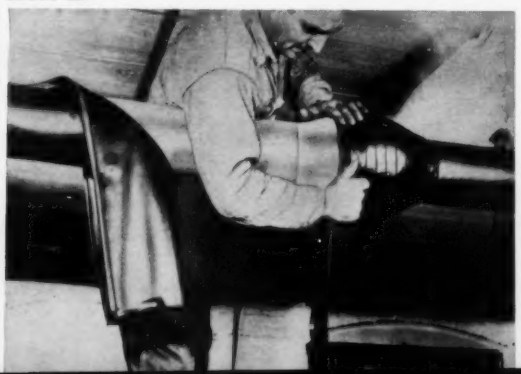
Courtesy FlexiGrip, Inc.

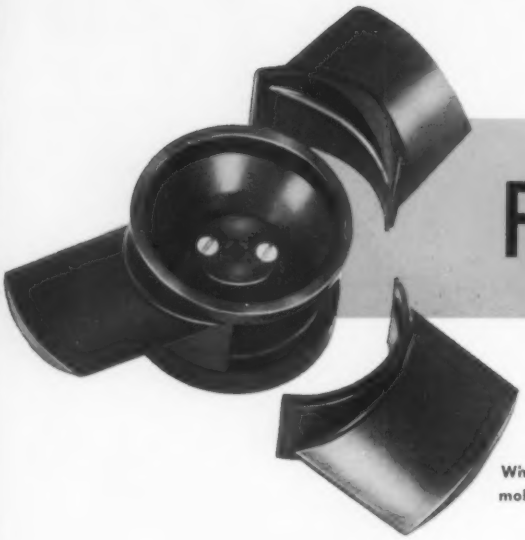
Because of plastic zipper, insulating cover for pipe can be installed at low labor costs, is easy to remove for servicing pipe

To complete the protective seal around the pipe, the ends of the zip-on covering are tightly wrapped with vinyl tape

Photos courtesy Bakelite Co.







FAN PARTS DESIGNED FOR

When the two halves of the fan hub are joined together, the molded styrene blades are locked securely between them

PRECISION molding that produces styrene fan blades evenly balanced within a fraction of an ounce is given the lion's share of credit for the success of a new home ventilator. As designed by Trade-Wind Motorfans, Inc., Rivera, Calif., the ventilator is based on the axial flow principle of air movement which emphasizes the use of aerodynamically balanced impeller blades shaped like airplane wings.

When the ventilator is in operation, the function of the revolving blades is to push air from the room through the conical-shaped housing of the ventilator and through ducts connected to openings in roof or outside wall. A venturi-shaped tube mounted in the housing gives the air flow an extra push ahead by increasing the velocity.

In order to concentrate the air-pressure drive for smoother, more powerful performance, a minimum of space must be maintained between the outside edges of the blades and the inside of the tube. It is therefore necessary that the blades be exactly the right length and evenly balanced to run true.

After considerable research, the answer was found in designing an impeller unit that could be molded entirely of high-impact styrene. The light weight of the molded styrene parts, coupled with the fact that the blades are hollow, also contributes to efficient operation by reducing vibration and noise to a minimum.

The impeller unit is located directly ahead of the motor and consists of three separate wing-shaped blades fitted to a two-piece cylindrical hub. To insure uniformity between the blades and, consequently, even balance, all three blades are injection molded in one shot on a 4-oz. machine. Hub parts are molded separately in a two-cavity mold.

Since the three blades and the two halves of the hub are designed to fit snugly together without the use of accessory attachments, molding the parts to uniform size is of extreme importance. The curved top and bottom inner edges of each blade fit into recesses molded-in around the periphery of the upper and lower hub halves. The three blade sections

Hollow fan blade sections are precision molded three at a time. Light weight and uniform size of sections contribute to efficient operation

Styrene fan parts include: grille and knob (top) and three fan blades, two halves of hub assembly, and locking ring (bottom)

All photos courtesy Trade-Wind Motorfans, Inc.

FIT and FUNCTION

Streamlined ivory-colored molded styrene grille for the home ventilator blends attractively with modern kitchen decor

are thus automatically positioned for maximum performance and, when the two halves of the hub are in place, the blades are securely locked between them. The assembled impeller unit is then attached to the motor shaft by a molded ring and two screws which compress a molded-in tapered and slotted boss around the shaft. This boss is in the half of the hub away from the motor. To disassemble the blades for cleaning, it is only necessary to remove the two screws

Styrene Grille

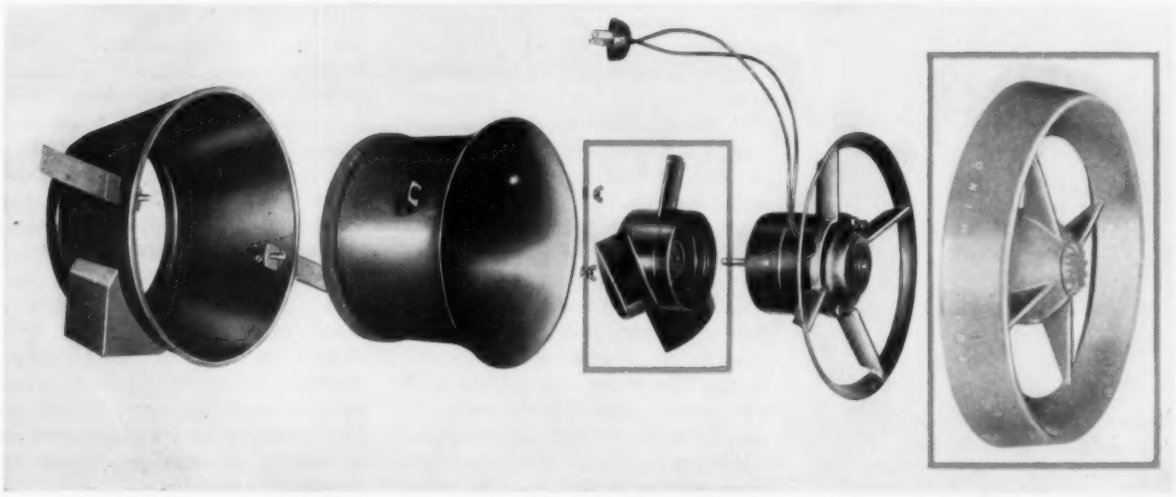
Molded high-impact styrene in the form of a smart, streamlined grille attached to the front of the unit plays an added role in improving the appearance of the ventilator. According to Trade-Wind Motorfans, the plastic grille represents one of the first switches in the home ventilation field away from conventional metal design. The manufacturers feel that the advantages of light weight, ease of cleaning, and sheer attractiveness have more than justified the decision.

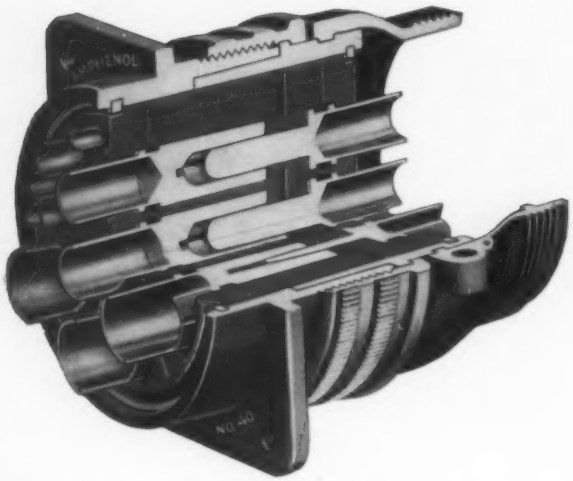
The design potential of styrene has also reduced manufacturing costs to the point where the highly efficient new model can compete price-wise with any similar unit on the market. The circular grille is molded in a single-cavity mold. The tradename of the fan is molded in raised letters around the outside of the grille. A deep rim is molded around the periphery of the grille so that any dirt or grease that might otherwise fall back into the room will collect in the trough of this rim or in the hollow ribs.

A small knob molded separately of styrene in a four-cavity mold is designed to facilitate assembly of the grille to the rest of the unit. A metal screw molded into the back of the knob passes through a hole in the center of the grille and then into the motor mount to lock the streamlined grille in place.

CREDITS: Styrene parts for Model AF-7 ventilator are molded for Trade-Wind Motorfans, Inc., by Fivel Injection Molders, Inc., Alhambra, Calif. Styrene supplied by The Dow Chemical Co. (Styron 475) and Koppers Co., Inc. (MC 309).

Exploded view of ventilator shows positioning of plastic parts (in color boxes). Room air is drawn through grille at right by the revolving fan blades, forced through venturi-shaped tube mounted in housing (far left), and discharged outside the house





Cross-section of typical electrical connector designed to meet Army-Navy specifications. Dielectric material (blue) is diallyl phthalate

Complex engineering, delicate design, thorough testing, and precision molding of many kinds of plastics go into the production of

Electrical

Compact multiple plug-in diode unit completes 12 diode circuits simultaneously; contacts are insulated with molded diallyl phthalate

MILLIONS of parts and thousands of miles of wire and cable, made with more than a dozen types of plastics to meet the rigorous standards of the aircraft, communications, electronic, and related fields—that, in brief, is the production story of one of the world's major producers of the thousands of electrical components so vital to so many industries today. Founded in 1933 with radio tube sockets as its principal product, American Phenolic Corp., Chicago, Ill., today lists some 11,000 separate items in its highly specialized catalogs. And plastics usage has expanded from only phenolic to include numerous materials in both the thermosetting and thermoplastic categories.

Important among the special properties required for many electrical and electronics applications are temperature and arc resistance, low or non-existent moisture absorption, dimensional stability, impact strength, dielectric strength, and low molding and post-molding shrinkage, as well as good aging characteristics. As performance demands grow increasingly stiffer, evaluation of materials must be ever more exacting. The wider over-all usage of electronic components by industry, coupled with rapid advancements in television and radar, highly intricate computer equipment, and the trend to miniaturization, are among the factors which keep the company engineers on their toes to meet constantly changing requirements.

As these fields have expanded, and as equipment needs have grown more involved, Amphenol and other basic suppliers have been called upon to produce increasingly complex components, many of them depending heavily upon molded or extruded plastics. Thousands of these parts are made in conformity with Army-Navy (A-N) and other military specifications, which demand the ultimate in materials, design, and manufacturing standards.

Aircraft, Missiles, Submarines

As an example to point up the need for such a diversity of plastics or part-plastics components, consider the complexity of a modern military airplane, which carries hundreds of pounds of complicated electrical and communications equipment, squeezed into the smallest possible space and built to facilitate quick servicing. Hundreds of electrical connections are involved, along with miles of wiring. And everything must be reliable under all conditions, including operation at sonic or near-sonic speeds and at lofty altitudes where pressurization of certain electrical equipment is frequently necessary.

Development of miniaturized electrical parts demands miniature connectors. These tiny parts, both push-on and screw-on types, are designed around Teflon insulation

Standard plug-in units minimize maintenance on digital computers; built-in test box checks circuitry rapidly

Parts by the Millions

Vibration, heat, and terrific acceleration changes are among the operating conditions encountered in both airplanes and, magnified in degree, in rockets and guided missiles. But in the latter there are equally tricky problems before take-off that have been solved by plastics. For example, in the Chance Vought "Regulus," the Navy's prime surface-to-surface missile, a special type of connector has been produced through which electrical impulses are transmitted by means of an "umbilical cord" prior to the launching of the weapon. This connector, involving heavy spring-loaded pressures to maintain secure electrical contact until the rocket is released, had to be designed so that it would break away cleanly when the rocket was launched. This connector, which includes 66 electrical contacts, employs special types of diallyl phthalate as the insulating material.

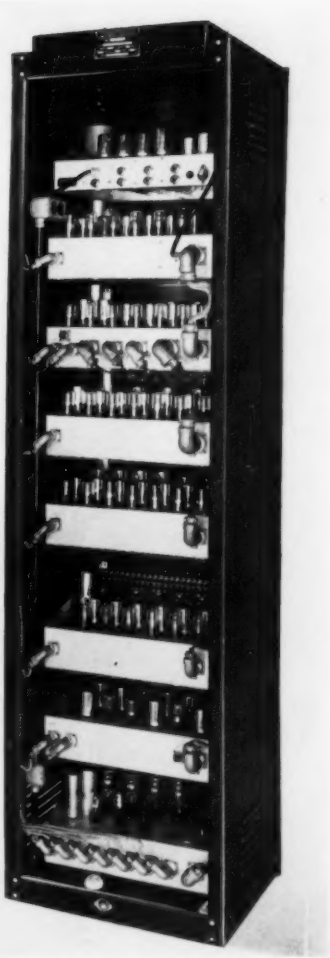
Another special connector, used on submarines, is also of breakaway design. This component, molded of fibrous glass-polyester laminate, replaces an earlier unit made of cast aluminum, eliminating costly casting and machining operations. In the event of a national emergency, the plastic connector body could be rapidly placed in accelerated production and would make possible important time and cost savings. The reinforced plastics component also eliminates a porosity problem encountered with its metal counterpart. It is designed to withstand a maximum operating pressure of 600 p.s.i.

List Almost Endless

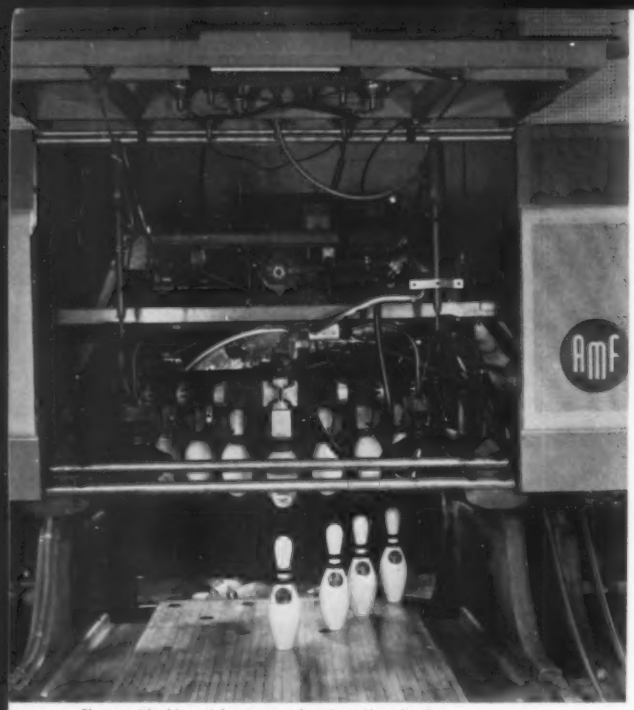
Described thus far are a few highly specialized types of connectors produced by American Phenolic; the complete list of connector applications is almost endless, ranging through the whole intricate gamut of all kinds of electrical and electronic equipment.

In the field of spectator sports, for example, the world's largest and most complicated baseball scoreboard, built by All-American Scoreboards, Inc., Pardeeville, Wis., and installed in New York's Yankee Stadium, incorporates some 105 Amphenol 47-contact plugs.

In the realm of participant sports, another example of plastics-based electrical connector and cable use is in the automatic "pin-spotter" machine for bowling alleys, made by American Machine & Foundry Co. This almost human machine is set into operation when a ball hits a



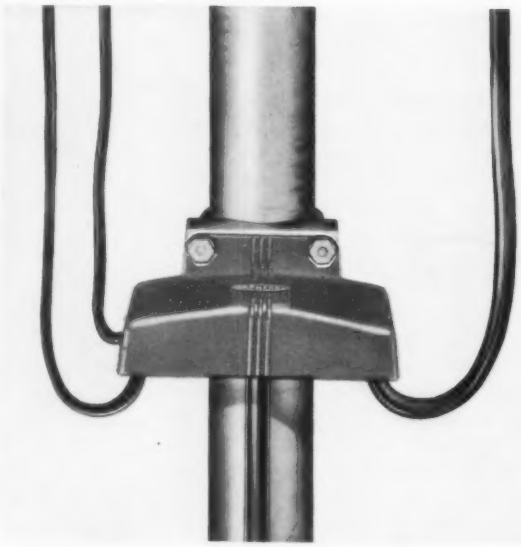
Frequency divider equipment uses a variety of angle plugs and receptacles



Pinspotter, an almost human machine for automatically setting up pins in bowling alleys, makes use of electrical connectors and cables of many sizes and types. In photo at left, machine has replaced pin in exact "offspot" position from which it was lifted to permit clearing of deadwood

Photos with this article courtesy American Phenolic Corp.

Housing for network circuit which couples separate u.h.f. and v.h.f. antennas to a single transmission line is molded of blue butyrate, gives protection against weather



Below: Cable harness tester is an example of specialized equipment in which efficient electrical connectors facilitate handling of extremely intricate circuits

cushion at the end of the alley. The unit includes Amphenol connectors and cables of many types of sizes.

A recently developed type of digital computer developed by Logistics Research, Inc., Redondo Beach, Calif., reportedly utilizes some 500 Amphenol "Blue Ribbon" connectors in rack and panel type applications. The electronic components of this compact machine are arranged in standard plug-in type units to minimize maintenance. A new multiple plug-in diode unit made by Electronic Engineering Co. of California, incorporating Blue Ribbon connectors, provides a rapid means of inserting and removing diodes from a circuit, plus the added advantage of having them encased in a dustproof, moisture-resistant package.

Molding Methods

In the production of connectors, Amphenol makes extensive use of the transfer molding process, since many of these units incorporate multiple metal contacts which must not be forced out of position during the molding operation. Multiple cavity dies are widely used, along with specially designed types of insert loading fixtures to expedite efficient production cycles. Through close attention to die construction, plus close control of the molding operation, flash is held to a minimum. There is also a decided trend at Amphenol to completely automatic molding.

Amphenol's rigid quality control program on connectors exemplifies the care taken in production of all plastic components. At the outset, every batch of molding compound is checked for both physical and electrical properties before being released for use. The qualification test includes the molding of test bars and disks on which the necessary checks may be run. This is followed by in-process inspection and quality control checks along the line.

Torture Tests

A unique machine is used in a typical "torture test" run on Blue Ribbon connectors. The connectors are placed in this machine in the quality control laboratory and the rate of insertion and withdrawal time is set at 120 cycles per minute. A series circuit is set up in which 5 amp. of current flow through all

contacts of the connector when it is mated. In a representative test, the durability machine was started and checked at frequent intervals for interruption of current through the contacts. The first intermittent operation of any contact was observed after 95,000 insertions and withdrawals of the mating connectors.

In another test, six connectors were subjected to a shock of 50 G in each of three planes, using a government specified testing device. No cracks or damage were visible under a four-power magnifier after these tests, nor were there any differences noted in mating of the connectors.

Specialized Materials

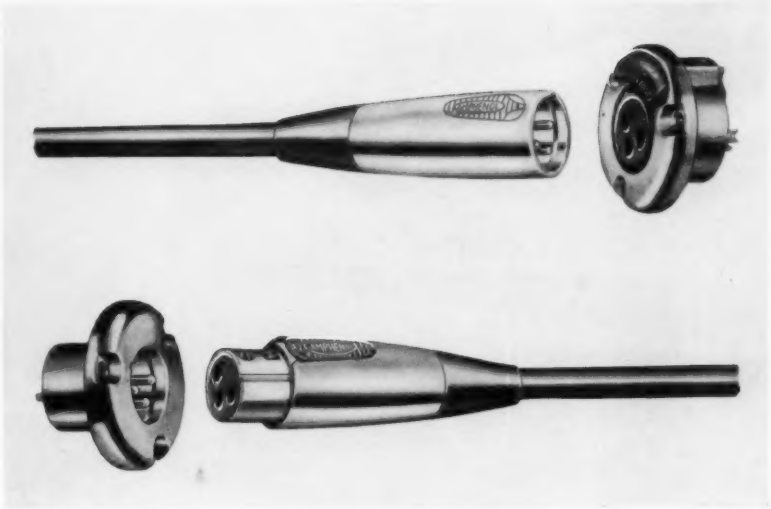
An excellent example of Amphenol's use of specialized plastics is the adoption of diallyl phthalate thermosetting material for many types of connectors. In earlier years these connectors, made in a wide range of types and sizes, were molded of general-purpose phenolic material. Later, as military specifications were modified, alpha-filled melamine was used. Then, in an effort to obtain a molding material with improved dimensional stability, lower post-molding shrinkage, and continued strength during aging, especially in larger parts, Amphenol set up a development project, working with independent consultants and a material manufacturer.[1] The result of this program was the development of the diallyl phthalate which Amphenol now uses in an identifying dark blue color.

The diallyl phthalate molding compounds maintain their electrical and mechanical properties despite extreme humidity, high temperatures, or both. The materials are molded in standard compression or transfer molds, as designed for phenolic molding compounds, and cure by polymerization without releasing volatile by-products. In general, their curing cycle is somewhat longer than for general-purpose phenolic.

With diallyl phthalate, Amphenol reports that it can hold dimensional tolerances as close as ±0.002 in. in regular production, and even as low as ±0.001 if required. The various diallyl phthalate formulations used by Amphenol have a post-molding shrinkage (in./in.) ranging from

(*To page* 200)

[1] Acme Resin Corp., Forest Park, Ill.

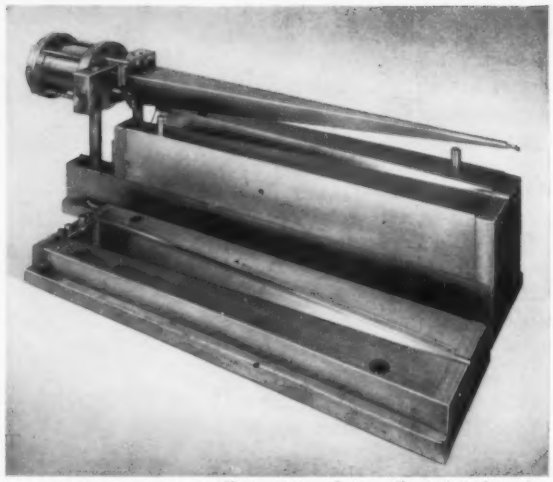


Molded diallyl phthalate (blue in illustration above) contributes to efficiency of quick-release microphone connectors, made in both male and female types

The dimensional stability and electrical characteristics required in mounting panels for crystals used in electronics are supplied by diallyl phthalate

Below: In low-temperature test, cables bent over mandril ten times their outside diameter are held at —40° F. If cracks develop, entire cable run is rejected

Furniture legs in variety of sizes, shapes, and finishes are covered with molded butyrate sleeves



Mold for triangular leg sleeve (bottom leg in illustration above), with air cylinder and tilting mechanism

Photos courtesy Eastman Chemical Products, Inc.

Kick-Proof Legs

THE new look in tables and chairs for modern dinette furniture centers around molded butyrate legs that can withstand scuffing and hard knocks, that won't peel or rust, and which are easy to keep clean. From the standpoint of appearance, the butyrate legs also have much in their favor. Made by fitting a molded sleeve over a framework of steel tubing or rod, the legs are characterized by smooth, tapering lines and by the lustrous surface finish inherent in molded butyrate. Available colors in this line of furniture legs are chip-proof black, grey, and a woodgrain effect.

Tilting Mold Mechanism

The molded butyrate legs are available in oblong or triangular shapes and in sizes that run from 14 in. long chair legs to 29 in. long table legs.

Because of shape and length and the fact that the legs are cored to facilitate assembly to the metal framework of the table or chair, the most difficult part of the molding operation proved to be the removal of the finished leg from the mold. To accomplish this as efficiently as possible, the core is tilted when the mold is opened so that the molded leg projects off to one side. With the molded leg in that position, an air cylinder is then used to knock it off the core.

The longest piece in the company's line is a 29 in. long black triangular table leg injection molded on an 8-oz. machine. The molding cycle for this leg is 60 sec. and the molding operation involves automatic double charging of the cylinder for sufficient plasticizing capacity. Despite its length, however, the leg weighs only 14 ounces. The 14 in. long chair leg which is also included in this line weighs 6 ounces.

To achieve the wood variegation effect which is used for several of the molded legs, light brown butyrate molding powder and dark brown butyrate powder are mixed together in the proper proportions before molding. The normal flow pattern into the mold creates the desired effect. These pieces are all gated at the small end.

Assembly

Assembly of the molded legs to the steel tubing framework is relatively simple. As described by the manufacturers of the dinette sets, the oval-shaped chair and table legs are attached to the metal frame by force-fitting the sleeve over a bend in the metal tubing.

The triangular-shaped legs are attached by fitting them over a welded framework consisting of three solid metal rods. These rods are welded together at their apex which, when inserted in the sleeve, rests on a shoulder in the inside of the small end of the leg cover. A brass foot slipped on over the outside of the small end of the sleeve completes the assembly.

The molded butyrate legs are currently being used by two companies — Modern Steelworks Ltd., Montreal, Canada, and Canadian Marconi Ltd., Ville St. Laurent, Canada —in a wide range of dinette table and chair sets. The colors used in upholstering the chairs and covering the tables in these sets are chosen to harmonize with the colors of the butyrate legs.

In addition to table and chair legs, the molded butyrate sleeves are used in the design of attractive, rugged television stand legs. One such unit currently on the market uses a short butyrate cover at the bottom of a metal leg; another makes use of a full-length molded butyrate sleeve with a small metal rod through the center. This rod is screwed at one end to the metal foot of the leg and at the other end to the frame of the stand.

CREDITS: Legs are molded by Blaines Plastics Co. Ltd., St. Hyacinth, Canada; Tenite II butyrate supplied by Eastman Chemical Products, Inc.

Furniture legs that

can withstand scuffing

and hard knocks

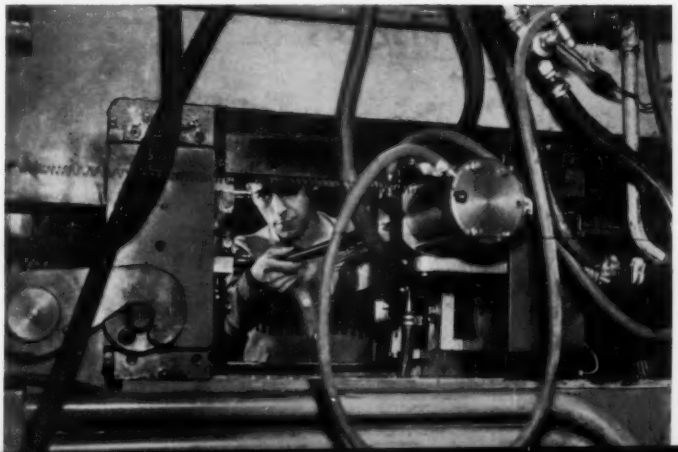
are made of molded

butyrate sleeves fitted

over metal tubing

Colors used in upholstery and on table top of modern dinette furniture are selected to harmonize with the black, grey, or wood-grain of the butyrate legs

Molded butyrate sleeve for television stand leg with circular cross-section, being removed from mold. Core is tilted in mold-open position to facilitate removal of piece



Another view of same mold shown in illustration above. Air cylinder near center of picture is used to knock molded pieces off the core

MODEL SPEEDBOAT VACUUM FORMED

Ease and economy of forming styrene sheet material open new vistas for plastics in the do-it-yourself powered model field

THE successful introduction of a vacuum formed model speedboat to the profitable do-it-yourself hobby field has opened the door to an important market for this newest —and one of the most exciting—of fabrication techniques. Taking advantage of the ease with which the three-dimensional parts of the unassembled model can be formed, manufacturers are now able to produce low-cost construction kits that can easily be assembled into strong, lightweight, and attractive units.

The entire hull of the engine-driven speedboat is vacuum formed in two parts of styrene sheet in what is claimed by the manufacturers of the kit to be the very first application of the technique to the powered model field. The manufacturers, who also turn out a line of detailed molded plastic and balsa wood model boats, further report that the success of the technique in this application has already stimulated research on the possibilities of extending vacuum forming production into other phases of their operations.

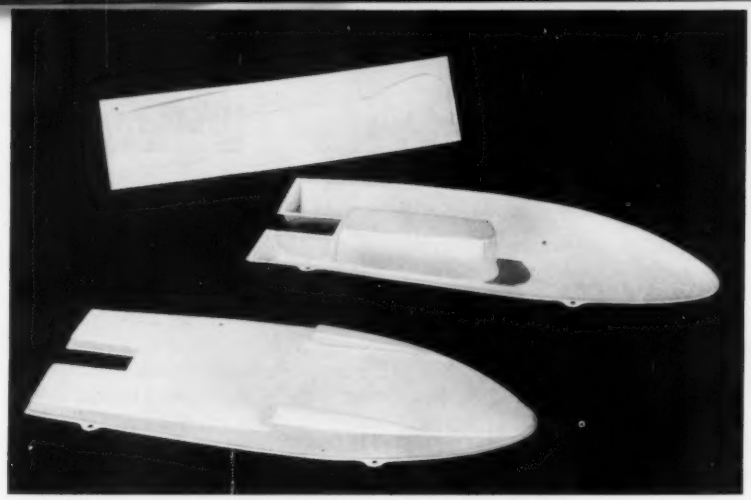
The 16 in. long by 6½ in. high speedboat is a three-point hydroplane designed exclusively for motor propulsion and adaptable to either a gasoline or electric motor. Called the Sea Dart, the boat is supplied unassembled to the hobbyist in a kit that includes, in addition to the streamlined hull, a styrene cockpit fairing and styrene motor mounts. Decorative decals, integral bridle mounts, and assembly instructions are also part of the kit.

Prior to the actual production of the boat, a number of experimental models were made by hand and tested for speed. When a final design had been decided upon—one that would permit the lightweight boat to literally skim over the surface of the water—the production line was set up.

In choosing 0.040-in. styrene sheet for the hull and several of the other components of the boat, the manufacturers report that they were most influenced by the ease with which the material could be formed, its toughness, its light weight, and, most important, the fact that it is unaffected by either fresh or salt water.

Forming the Hull

The hull, which is, of course, the largest and most important section of the boat, is formed in two parts—the shell and the deck—on a custom-built vacuum forming machine. Four shells and four decks, which are later combined to make four complete hulls, are formed at one time of the 34- by 37-in. styrene sheet. The forming temperature is 550° F.



Top and bottom half of speedboat hull are vacuum formed from styrene sheet; accessory parts are partially die cut into flat styrene sheet (top), snapped out during assembly

and the complete forming cycle takes only 90 seconds. In keeping with the economical set-up of the production line, sprayed-metal molds with reinforcing aluminum inserts in critical areas, are used.

The biggest technical problem that faced the fabricator in the production of the boats was finding the proper method for die cutting the formed sheet. Originally, the formed sheet was cut in half along the center and the one half containing the four decks was placed over the other half with its four shells and cemented together. The individual boats were then cut out of the joined sheets. This method proved unsatisfactory, however, because of the fact that the solvent seal at the seams tended to buckle during cutting.

With the improved technique in use today, the individual halves of the boat are each cut out of the sheet with a straight edge steel die rule and joined together with cyclohexanone, a plastic solvent. Air-operated presses are used during the cementing operation to insure a secure, waterproof bond.

The port side of the hull has two die cut holes on the horizontal seam; guide lines that serve to control the course of the boat can be secured to these holes.

The complete hulls are shipped by the fabricator to the manufacturer who packages the hulls, together with the accessory parts such as motor mounts, stabilizing fins, and cockpit enclosure, in an illustrated cardboard box. The accessory parts are partially die cut into a sheet of 0.040-in. styrene. During assembly, the hobbyist simply snaps the parts out of the sheet and cements them to the hull.

A further indication of the potential of the vacuum forming process in the hobby field comes from the West Coast where it is reported that one manufacturer is planning to market a powered model airplane with a vacuum formed styrene body.

CREDITS: Styrene hull is formed by Glidden Coating Co., Pitman, N. J., for Sterling Models, Philadelphia, Pa. Heating unit for forming machine supplied by Thermomat Co., Inc., Trenton, N. J. Styrene sheet supplied by The Dow Chemical Co.

Parts formed in an eight-cavity sprayed-metal mold reinforced with aluminum inserts will produce four complete speedboat hulls

Courtesy Glidden Coating Co.

While the formed sheet is still warm and held in place by the retaining frame, excess material is trimmed off and the finished sheet removed

Completed hulls are produced by placing top and bottom halves of hull in press and bonding them together with solvent-type cement

Photos courtesy Glidden Coating Co.

Chlorinators That

Rugged reinforced plastics housing for chlorinator is lighter in weight than comparable metal cabinets and completely resistant to moist chlorine gas

HEAVY maintenance costs on metal chlorinator parts used in controlling chlorine gas for water purification processes have been sharply reduced by designing a unit around major components fabricated of corrosion-resistant reinforced plastics, styrene copolymer, fluorocarbon, and vinyl.

Basic function of the chlorinator is to kill disease producing organisms in drinking water or waste water by injecting gaseous chlorine in solution into the body of water that is to be purified. In the operation of the unit, it is essential that the chlorine gas be dissolved in water to insure proper dispersion.

Chlorine gas in the presence of moisture becomes highly corrosive, will readily attack most common metals, and is extremely difficult to handle. For this reason, chlorinators have long been among the most difficult pieces of equipment to produce and market.

High Costs

As a result, maintenance and operating costs on chlorinators based on all-metal construction run high. Under the ravages of chlorine gas in solution, steel or cast iron cabinets and iron or copper alloyed piping and fittings have relatively short service lives.

Corrosion-preventive measures, in most cases, consist of painting the metal parts or coating them with grease. Because the paint can become chipped or will peel off, however, and because the gas will eventually combine with the grease, it is necessary that these operations be performed frequently—and the parts have to be checked almost every day for possible leaks.

In many instances, despite all precautions, various metal components in chlorinators will corrode after several months of service and most users of such chlorinators are required to keep a stockpile of these components on hand to provide for frequent replacement. It is also customary, when using the all-metal chlorinators, to make provision for annually rebuilding many of the essential components.

Thus faced with the persistent problem of corrosion, Fischer & Porter Co., Hatboro, Pa., manufacturers of chlorinators, turned their efforts to developing a unit that would take full advantage of the corrosion resistance of modern plastics materials. After four years of exhaustive laboratory and field tests, the smart new chlorine dispenser, with practically all of its major components fabricated of plastics, was placed on the market.

Each component in the chlorinator is fabricated of that particular plastic best suited to withstand the maximum degree of corrosion to which the part is exposed in the operation of the unit.

The largest of the plastics parts is the reinforced plastics cabinet in which all the parts of the chlorinator are housed. Fabricated in two sections of polyester-fibrous glass laminate and then joined together, the rugged cabinet of the Model 1050 chlorinator stands 57 in. high, measures 18½ in. wide, and weighs only about 33 pounds. The entire unit, in fact, weighing only 70 lb., is light enough to be lifted by one man. Chlorinators with metal cabinets and metal parts, in sharp contrast, weigh as much as 300 lb. and have to be placed in position with a crane.

The reinforced plastics cabinet is, of course, completely impervious to chlorine and its corrosive compounds, and is unaffected by heat or cold. Since the attractive grey coloring is integral with the laminate, even deep scratches can hardly be noticed. Painting is never necessary.

The front and the rear of the cabinet are produced separately in aluminum female molds. The rear section is actually a shallow piece molded with a large rectangular opening in the center which provides easy access to the internal parts of the chlorinator.

After a gel coat has been sprayed on the interior surfaces of the aluminum molds, four layers of fibrous glass mat impregnated with polyester resin are manually laid up to a thickness of approximately ⅛ inch. The pieces are then bag molded and allowed to cure at room temperatures. Heating equipment is currently being installed to accelerate curing time.

After curing, the rough edges of the two molded parts are trimmed with high-speed routers and buffed and sanded down. The front and rear parts of the cabinet are then joined together by placing strips of polyester-impregnated fibrous glass cloth along the meeting edges of the two halves and allowing the joining strips to cure into an integral part of the cabinet.

To accommodate the various instruments and dials that are installed on the face of the cabinet, holes are drilled through the front

Resist Corrosion

Housing of reinforced plastics and parts made of styrene copolymer, fluorocarbon, and vinyl prevent corrosion damage to water purification unit

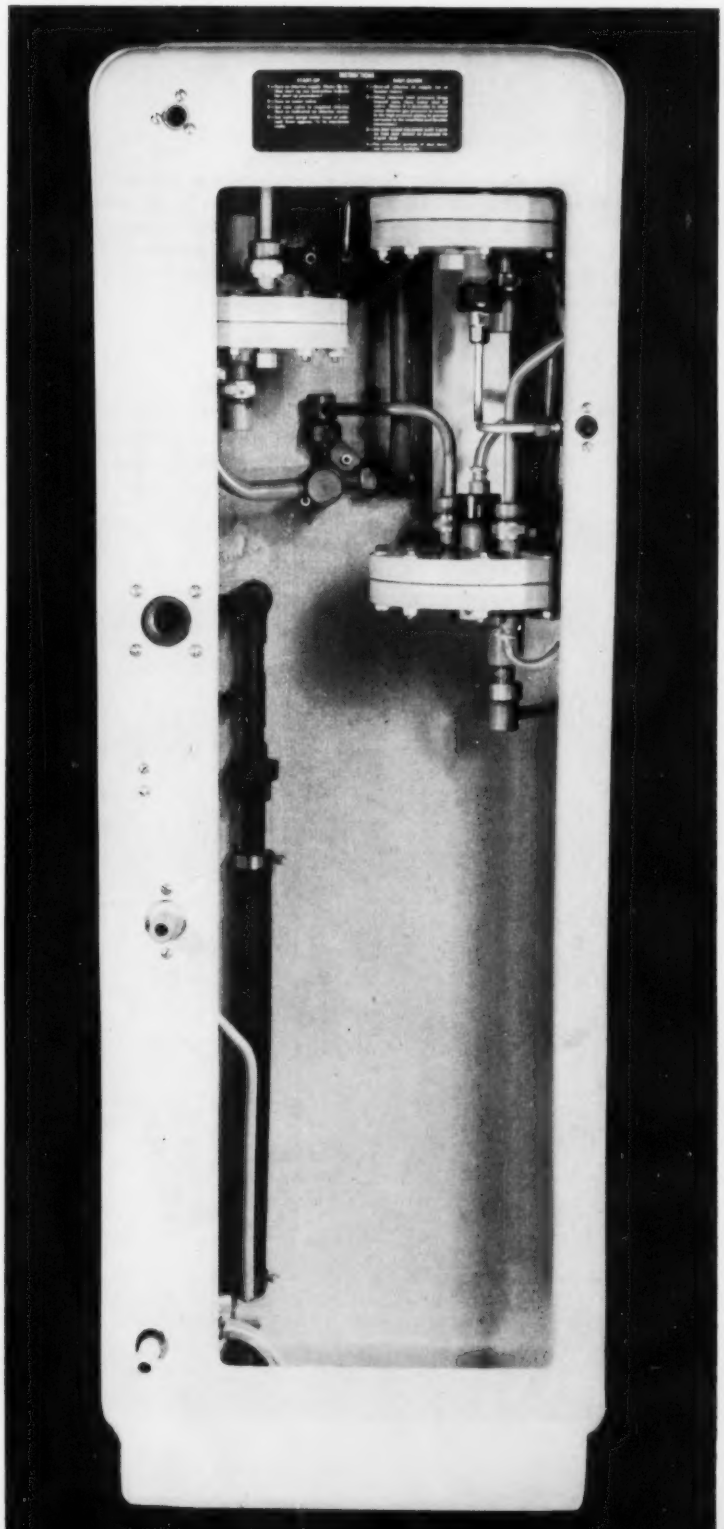
wall of the housing and the accessories are bolted in place. Molded into the front of the housing is a protective alcove into which an easy-to-read meter for measuring the flow of chlorine under vacuum is bolted.

In the internal mechanism of the chlorinator, plastics again play a leading role. The chlorinator is designed so that the chlorine being fed through the various processing steps and out into the water supply travels only through corrosion-resistant plastics pipes. Each unit of processing equipment is also contained in a plastics housing. Unlike chlorinators that use metal parts, no dependence is placed on fluids to seal chlorine gas from the atmosphere. Thus, there is no possibility that chlorine gas might escape into the room as a result of chlorine-saturated water seals.

Styrene Copolymer

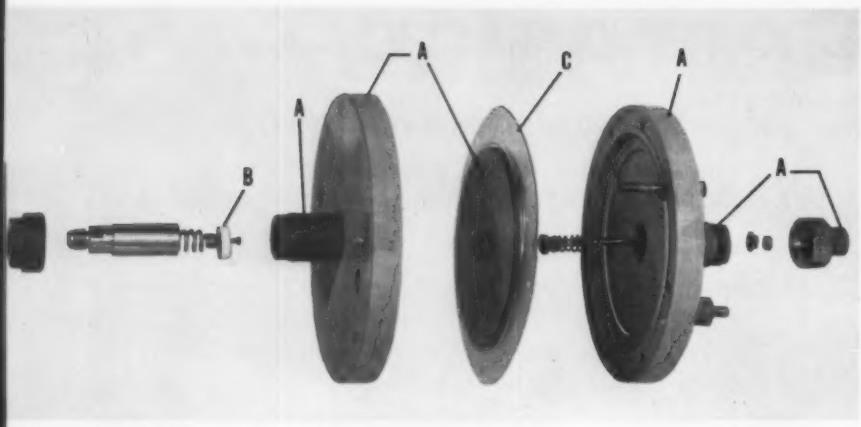
The majority of the internal parts of the chlorinator are fabricated of styrene copolymer sheet, rods, or tubes, and include most of the piping and parts of a vacum regulator, a vacuum breaker, and a differential pressure regulator. Most of the components are machined from stock in the plant of Fischer & Porter. Molded standard pipe fittings, elbows, and pipe connections are purchased from outside suppliers.

The selection of the styrene copolymer material for the application was made after a full year of field testing under accelerated conditions and was based on the exceptional resistance of the material to moist and dry chlorine service, its resistance to most other chemicals, its



Photos courtesy Fischer & Porter Co.

Rear part of polyester-fibrous glass housing is bag molded with large opening in the center to provide easy access to the internal parts of the chlorinator. Because the attractive grey coloring is integral with the housing, painting or frequent touch-ups are unnecessary



As chlorine gas enters the chlorinator, it passes through vacuum regulator (exploded view, above) where the gas is reduced from vapor pressure to a partial vacuum. Practically the entire regulator is fabricated of plastics. Uscolite styrene copolymer parts (marked A) are machined from sheet or tubing; Teflon tetrafluoroethylene gasket (B) is molded and Kel-F trifluorochloroethylene seal (C) is fabricated from flat sheeting

light weight, and its great impact strength.

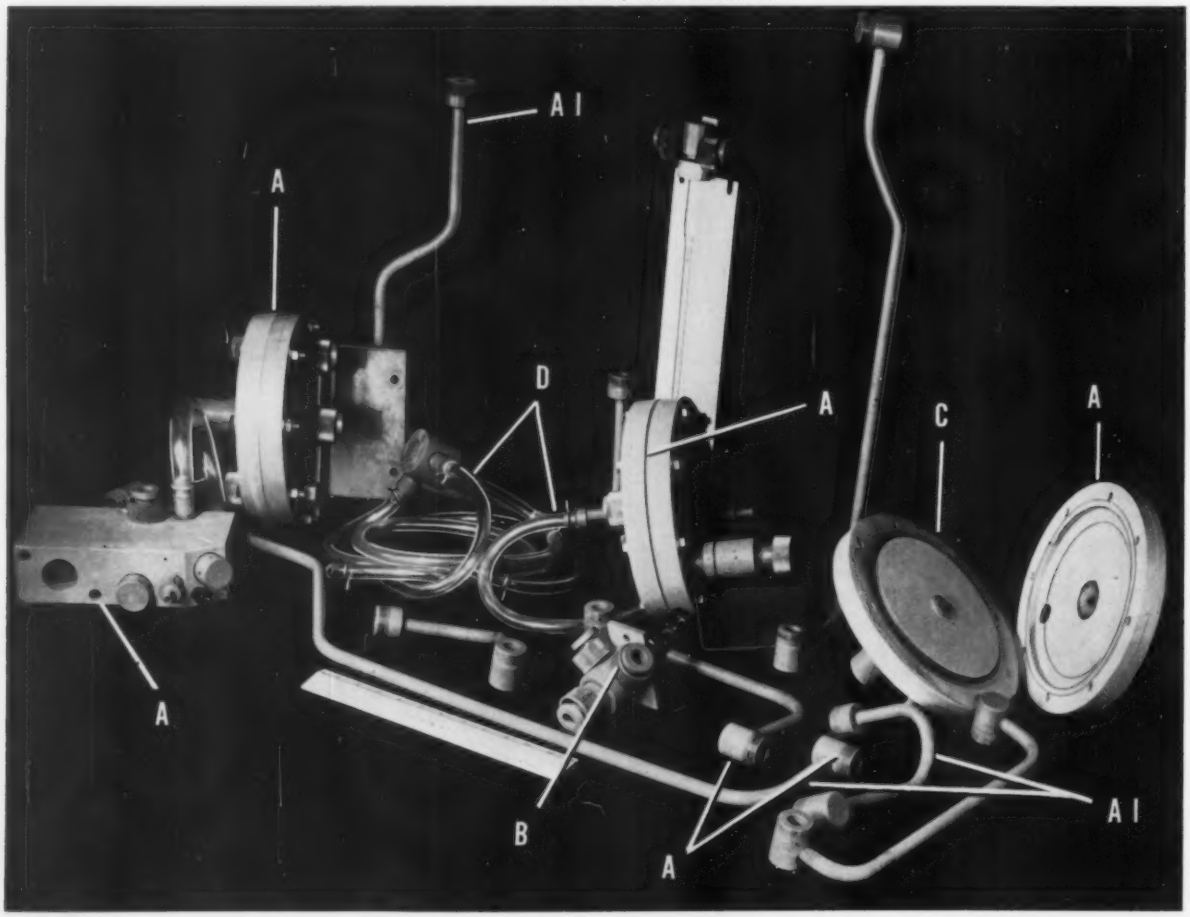
Used in smaller volume in the internal design of the chlorinator are fluorocarbon parts. Most of these parts are standard molded gaskets and seals which are purchased from suppliers. In several of the applications, however, where unusual shape and size are required, Fischer & Porter form their own pieces from flat fluorocarbon sheets.

In selecting fluorocarbons for the construction of the chlorinator, the material's excellent resiliency for effective sealing applications was a prime consideration. In addition, fluorocarbons are also resistant to corrosion and are self-lubricating. They are, therefore, ideal for applications in the chlorinator where mov-

(*To page* 206)

Complete array of internal plastics components illustrates heavy reliance on plastics for reliable, trouble-free operation of the chlorinator. All three cylindrical regulating units (center and on the ends) have the same basic construction as shown in the exploded view above (A—machined Uscolite parts; B—Teflon gaskets; C—Kel-F seals) and are all fabricated to the same dimensions so as to be interchangeable. Also included among the plastics parts are Uscolite piping (A1) and the clear Tygon vinyl tubes (D) which carry a small flow of air or water and serve as purge lines

Photos courtesy Fischer & Porter Co.



Styrene housing atop live bait bucket contains battery-operated pump that forces air through vinyl tube to aerate water in bucket

View of disassembled unit: four dry cells nest in lower half of case; styrene chassis (rear) on which pump is mounted fits into upper half

New Pump Keeps Bait Alive

Molded styrene is used in fishermen's accessory because of inherent desirable properties

FIVE molded plastic parts play an important functional role in the operation of the Bait-air-ator, an ingenious new type of self-contained pump which makes it possible for fishermen to keep minnows and other live bait for long periods. Developed and distributed by Silco, Inc., Nashville, Tenn., this device, except for the electrical components, is constructed almost entirely of plastics, which were specified because of their resistance to rust and dampness, light weight, reasonable cost, and inherent color.

By utilizing the Bait-air-ator to maintain plenty of oxygen in the water within their live-bait buckets, sportsmen may safely purchase minnows, crayfish, shrimp, and other natural baits with assurance that they will be alive and vigorous when needed. With this device, it is claimed, minnows can be kept alive for weeks or even months if necessary. The diminutive but powerful electric pump, completely enclosed within the bright red molded plastic case, will operate for at least 24 hours on four small flashlight batteries, continuously forcing millions of fresh air bubbles into the water. Provision has also been made for plugging the unit into 6- or 12-volt automotive cigaret lighter sockets.

Outer dimensions of the Bait-air-ator case are approximately 3 by 3¼ by 5 inches. Extending from the case is a 36-in. black vinyl tube through which the air supply is carried to the minnow bucket.

All plastic components of the Bait-air-ator are molded of high-impact styrene. The upper and lower halves of the outer housing are produced in a two-cavity mold. A second set of molds has two cavities for the chassis, on which the pump mechanism is mounted, and two each of the circular valve seats and a small block-like part which anchors the air outlet tube to the chassis.

The top half of the case is made with a small recess in one corner in which the terminal board and toggle switch for the Bait-air-ator are mounted by means of two rivets. Cored fillets at each end of the top provide a method of mounting the molded plastic chassis in position by means of thread cutting screws. Similar ribs on the sides of the top contain additional holes for screws which serve to anchor the chassis in place.

The lower half of the case is designed with cored external ribs at each side. These ribs mate with others in the top half. At each end, both halves are "stepped down" so that, in the final assembly, the edges of the chassis are locked between them for a more solid construction.

The two circular plastic valve seats are joined by a short section of rubber tubing, within which a flexible rubber diaphragm is enclosed. In operation, the reciprocating electric drive mechanism produces a pulsating action of the pump unit, forcing air out through the feed tube.

CREDITS: Plastic parts for Bait-air-ator molded by Plastics Div., Kusan, Inc., Nashville, Tenn., using Styron high-impact styrene material supplied by The Dow Chemical Co. Final assembly of unit by Alladin Radio Industries, Nashville.

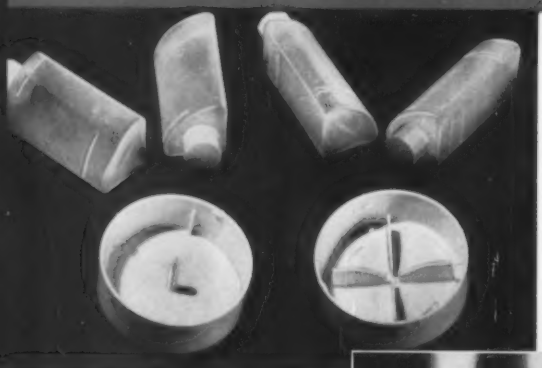
PLASTICS

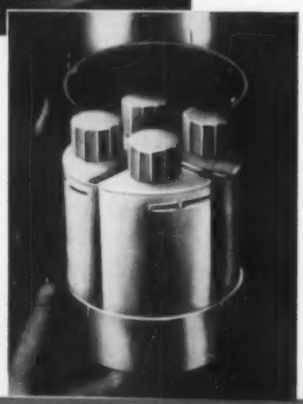
Polyethylene Dustpan

The use of polyethylene as a molding material for an easy-to-grip dustpan results in a household aid that will not break, rust, or dent, or scratch floors. It can also serve as a crumb tray and may be used on the most delicate table surfaces without fear of marring them. The flexible pan conforms to any surface to permit quick and complete dust pick-up. Once brushed on the pan's surface, dirt and dust are retained by three curved terraced ledges until emptied. Light hand pressure on the sides of the dust pan will form a convenient scoop for discharge of dirt into garbage can without danger of side spillage onto the floor. The surface of the polyethylene dustpan offers sufficient friction to prevent dirt from prematurely shaking loose, but not enough to make cleaning difficult. The versatile dustpan-crumb tray is currently available in red and yellow.

The unit is injection molded and is center gated on the back surface.

CREDITS: Molded and manufactured by Alladin Plastics, Inc., 5771 W. 96th St., Los Angeles, Calif. Polyethylene supplied by Bakelite Co., New York, N. Y.





Compact Cosmetic Kit

Cosmetic kit molded of polyethylene and styrene was designed primarily for use when traveling, but will also be equally useful in the medicine cabinet or vanity shelf at home. Called Travelette, the set consists of four wedge-shaped squeeze bottles that can be securely locked together in a compact unit by a styrene base and cover. The locking action is produced by turning cover and base; this engages molded-in lugs in the cover and base with channels molded into the 5 oz. bottles. The Travellette is available with white, pink, blue, or ivory bases and tops and includes a separate liquid and shaker dispenser. The bottles can be filled with any free-flowing liquid, cream, or powder.

The polyethylene squeeze bottles are blow molded. Styrene parts are produced by the injection molding process using a 14-cavity mold.

CREDITS: Molded by Millsplastic Div., Continental Can Co., Chicago, Ill. for Travelette Corp. of America, 745 5th Ave., New York, N. Y. Urea caps supplied by Colt's Mfg. Co., Hartford, Conn. Polyethylene supplied by E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Styrene supplied by The Dow Chemical Co., Midland, Mich.

PRODUCTS

Heat-Resistant Baby Nipple

Clogging of baby bottle nipples resulting from constant boiling or old age has been eliminated with the introduction of a silicone-rubber nipple called Anti-Colic. At the same time, the new nipple has an average useful life of nine months, much longer than its rubber counterpart. The ability of silicone rubber to resist adhesion of foreign matter is the prime factor in preventing the clogging of nipple holes. Normally, conventional nipples should not be boiled longer than 3 minutes. Now, 10 to 15 min. of boiling has no adverse effect on the life of the silicone nipple and will not result in nipples collapsing or becoming flabby and causing the baby to swallow air. The clear nipples are available in two styles: narrow neck and screw top types; they fit any commercial baby bottle.

The silicone nipples are compression molded (picture at right), using a 72-cavity mold with metal forming slugs.

CREDITS: Manufactured by The Davol Rubber Co., Providence, R. I., and Pyramid Rubber Co., Ravena, Ohio. Silicone rubber supplied by General Electric Co., Waterford, N. Y.

Versatile Bowls

Newly designed polyethylene bowls are not only functional but, because of the flexible nature of the material from which they are made, can be easily formed into a number of interesting shapes for decorative purposes. A thin cuff-like rim around the top of the 9-in. bowl can be made into one or more pouring spouts merely by folding or rolling it into the desired shape. The rim can also be twisted into decorative corners to produce bowls with polygonal tops.

The bowls have an unusual "venetian glass" appearance, produced by dispersing finely divided flecks of tinsel-like material through the polyethylene material during the molding process. The bowls are also available in a range of translucent pastels as well as in solid colors. They can be nested for storage.

In addition to their varied uses as decorative pieces, the bowls can also serve as conventional mixing vessels for general household purposes.

CREDITS: Manufactured by Plastic Metal Mfg. Co., 3550 N. Spaulding Ave., Chicago, Ill. Polyethylene supplied by Bakelite Co., New York, N. Y.

PLASTICS

Powder Dispenser Breaks Up Lumps

For use with soap powders, detergents, sugar, or similar material, Pres-Flo dispenser can measure a level teaspoon, a few grains, or provide a continuous flow. A built-in agitator, which can be rotated by twisting a button on the end of the shaft, serves to break up lumps in the contents. Attached to the lower end of the agitator is a polyethylene plug which fits into a hole in the bottom of the dispenser. Tension of a spring located between the button and the top keeps the plug in closed position, sealing in the contents. Depressing the button pushes plug out of hole and allows powder to flow.

Pres-Flo is produced in an 8-oz. injection molding machine using three separate molds of eight cavities each. Cover, base, agitator, and body are molded of styrene; top button and plug of polyethylene. Assembly consists of cementing the body to the base and the plug to the agitator. The agitator is then placed through the holes in the top and bottom sections. A metal spring is placed in a recess in the top and over the part of agitator protruding from the top of the unit and is held in place and under proper tension by the top button, which is friction fitted to the rod.

CREDITS: Made by Ultra Tone Co., 700 Ft. Washington Ave., New York, N. Y. Styrene by Koppers Co., Inc., Pittsburgh, Pa. Polyethylene by Gering Pdts. Inc., Kenilworth, N. J.

Three-Dimensional Painting Kit

Amateur artists can now produce striking oil paintings through the use of a new painting set, major part of which is a "canvas" which consists of a plaque molded of wood waste and a phenolic resin binder. The picture pattern is molded-into the surface of the plaque in bas-relief to emphasize highlights and to give an impression of depth in the finished painting. Sections of the pattern are numbered as a guide in the selection of correspondingly numbered paints. Design of the plaque is such that the painting area and the frame are molded in one piece. At present, the sets come in two picture sizes: 12 by 14 and 16 by 20 inches.

The units are molded on hydraulic compression presses using single cavity molds.

CREDITS: Molded by Tasker Associates, Div. Insulation Mfg. Co., Inc., 11 New York Ave., Brooklyn, N. Y. Phenolic binding resin by Monsanto Chemical Co., Springfield, Mass.

PRODUCTS

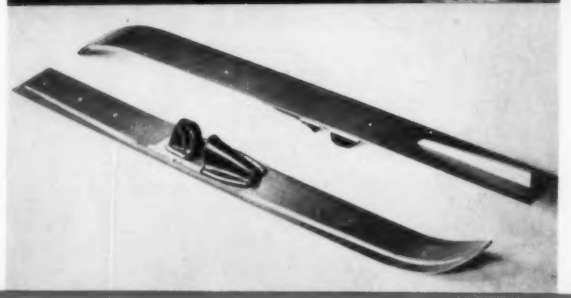
Durable Water Skis

The resistance of reinforced plastics to the corrosive effects of sea water makes them ideal for use in the manufacture of extremely rugged water skis. Molded completely of fibrous glass-reinforced polyester resin (with the exception of a flotation core to prevent them from sinking) the skis are lightweight and will not shatter. Because of the smooth, hard finish, the skis offer less frictional resistance to water than conventional wooden models. All colors are permanently molded-in and the skis never have to be painted or treated to protect their surfaces. The water skis are available in three models: General Purpose, Slalom, and Jumping Skis.

The skis are produced in matched metal molds and are of one-piece construction. This design adds greatly to the strength of the equipment and prevents warping, cracking, or splintering. The ski tips are formed during the molding process to a permanent curve and will not flatten out.

Each model is 6½ in. wide and 5 ft., 6 in. long. The skis are packaged complete in individual shipping cartons.

CREDITS: Molded and manufactured by Kimball Mfg. Corp., 1270 Pennsylvania Ave., San Francisco 7, Calif. Polyester resin supplied by Bakelite Co., New York, N. Y. Fibrous glass supplied by Owens-Corning Fiberglas Corp., New York, N. Y.



Thread Box With Individual Cutters

Designated Traum 28-Spooler, styrene box not only provides for neat and secure storage of up to 28 spools of thread, but also has 24 individual slots and cutters located around its periphery that facilitate securing correct lengths of thread. Thread is simply drawn through nearest slot and severed by adjacent cutter; a sufficient amount of spooled thread hangs out from the slot to permit additional lengths to be drawn. Thus, the box does not have to be opened until a spool is exhausted or the user desires pins, buttons, etc., that can be stored in two compartments molded-in at the rear of box. Unit is injection molded in two sections and the cover is hinged to the base by means of molded lugs in the base which engage two holes in the top.

CREDITS: Manufactured by David Traum Co., 11 E. 26th St., New York, N. Y. Styrene supplied by Dow Chemical Co., Midland, Mich.

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PLASTICS ENGINEERING*

F. B. Stanley, Engineering Editor

COLOR, PAINT, and PLASTICS†

Detailed consideration of formulations for spray and silk-screen application, and of finishes used on vacuum metallized surfaces

by LLOYD E. PARKS‡

PLASTICS engineers and designers make wide use of color as a result of the particular adaptability of plastics for intricate decorative design and display. Plastics—thermoplastics in particular—are available in a wide range of colors. However, some of the most interesting decorative effects are obtained through the use of paint. A number of colors can be used on one part to obtain the desired effect and some of the most beautiful effects involve second surface painting of clear plastic to give the appearance of depth to such objects as refrigerator and automotive parts, nameplates, and similar products.

In addition, and almost incidental to their decorative value in the plastics industry, paints may serve the functional purpose of increasing the resistance of plastics to abrasion, chemicals, moisture, and light.

Scope of Treatment

Methods of applying paint include spraying, silk screening, dipping, printing, roller coating, and brushing. However, this article is essentially concerned with spray and silk-screen formulations plus a discussion of finishes used in connection with vacuum metallizing of plastics.

In the plastics industry, the term "paint" is usually used to denote all decorative coatings for plastics. Broadly, paint is a dispersion of pigment in a liquid which forms a solid adherent film on the surface to which it is applied. The liquid portion of the formula is commonly called the vehicle and may vary widely in basic composition, as follows:

1) Resin-solvent systems: All lacquers and practically all enamels fall in this group. Most coatings used on plastics are of this type.

2) Resins dispersed in non-solvents: Emulsion paints belong to this group and are occasionally used on plastics.

3) Liquid oils and liquid resins: Straight oils and certain oleo-resinous materials fall into this group

* Reg. U. S. Pat. Off.
† Adapted from a paper presented at the Eleventh National Technical Conference of the Society of Plastics Engineers, Inc.
‡ Vice president and general manager, Logo, Inc., Chicago, Ill.

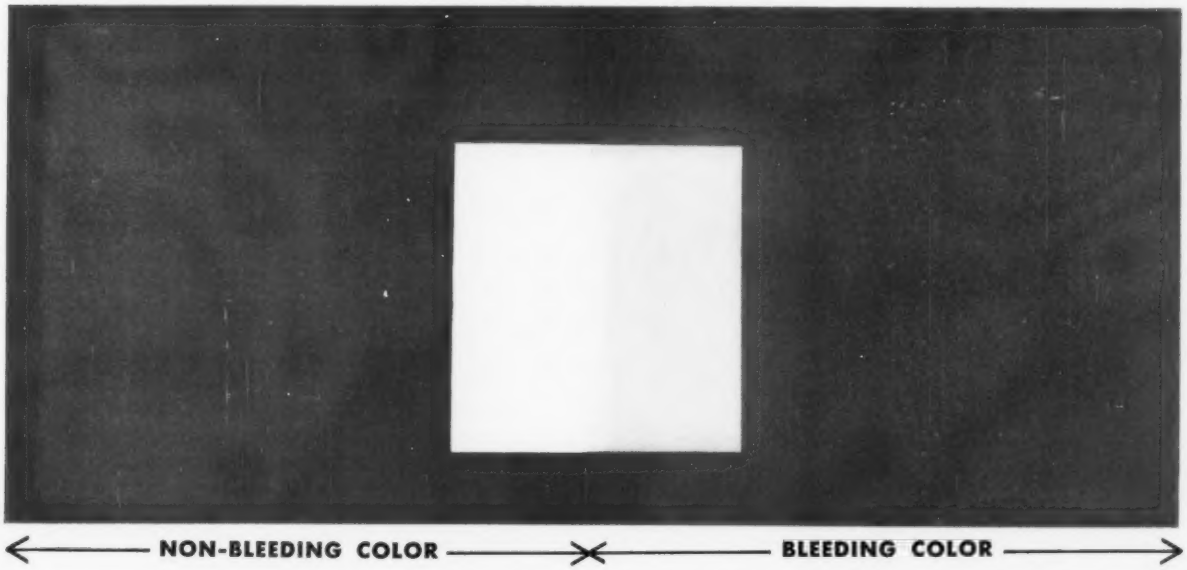


Fig. 1—Effects resulting from use of bleeding and non-bleeding colors in second-surface painting of clear plastic

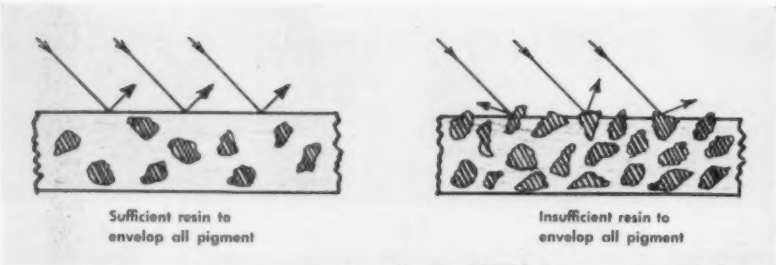


Fig. 2—Paint film cross-section showing effect of pigment-to-resin ratio on gloss

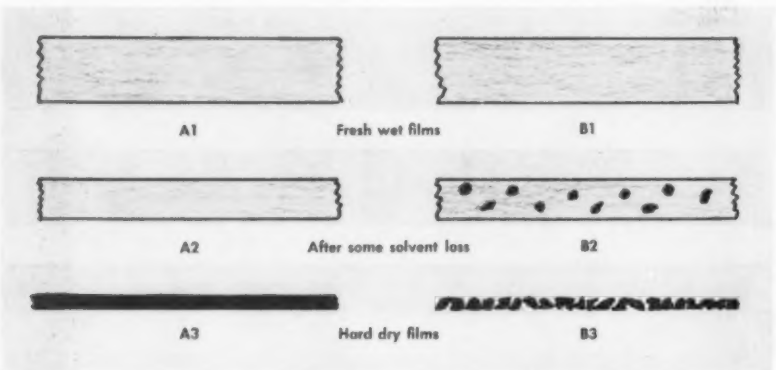


Fig. 3—Film cross-section illustrating humidity blush (see p. 104 for symbol definitions)

and may require no solvent in certain applications.

4) Hot melt systems: Pigments may be dispersed directly in certain molten resins which must be remelted for application. The film hardens upon cooling.

This discussion will be limited to paints with resin-solvent vehicles since practically all paints used on plastics are of this type.

Paint Development for Plastics

The Resin System: In general, paints formulated with resin-solvent vehicles are classified either as lacquers or enamels. They differ in the way they harden to a film when applied to a surface.

1) Lacquer: When a thin coat of lacquer is applied to a surface, the film hardens by simple solvent evaporation. The film is thermoplastic and, when completely dry, has exactly the same properties as the resins used in making the lacquer. Lacquers are particularly desirable for use on thermoplastics since the film hardens quickly and completely without baking. This eliminates subsequent heat shrinkage and warpage of molded parts. Also, parts rejected because of blotches or errors in painting can usually be reclaimed by removing the paint with a combination of solvents similar to that used in the paint.

It is possible to formulate hard, durable lacquers with excellent adhesion to most thermoplastic surfaces. Such film formers as nitrocellulose, cellulose esters, cellulose ethers, polyacrylates, and polyvinyls, and a host of base gums or film modifiers are used in such formulations.

2) Enamels: When a thin coat of enamel is applied to a surface, the solvent evaporates, leaving a rather soft, and often oil-like film, which hardens by oxidation or polymerization, or both, to a film with totally different physical properties from that of the resins used in making the enamel. Oxidation may take place at room temperature. However, baking is usually required to induce polymerization which is necessary in producing top-quality enamel films.

Enamels may be considered as thermosetting and are particularly useful for use on thermosetting plastics such as phenolic where a reasonably high baking temperature can be tolerated without damage to the plastic part. Air-cure and low-temperature-bake enamels are also used on thermoplastic materials. Such enamels cure essentially by oxidation and in general are of lower quality than enamels polymerized at higher temperatures.

A wide variety of oleo-resinous materials and alkyds are used in enamels. They cure both by oxidation and polymerization. Such modifiers as urea formaldehyde resin and melamine formaldehyde resins give improved hardness and light stability. These resins must be polymerized at temperatures of 200 to 400° F. which limits their use on thermoplastic surfaces.

Enamels have an advantage over lacquers in that they can be sprayed at a higher solids content and usually have superior gloss. As thermosetting materials, they have the disadvantage of being insoluble when cured; the film cannot be removed from parts rejected because of blotches and painting errors.

Properties Must be Considered

There are hundreds of resins of varying physical and chemical properties available for use in formulating paints. Each of these properties must be considered in light of the plastic surface to be painted. Also, there are many plastics of varying physical and chemical properties in use today. Each of these properties must be thoroughly understood and considered in developing a satisfactory paint for plastics. Certain resins may be used in paint for such thermosetting plastics as phenolics, polyester, urea, and melamine, but may be wholly undesirable for use on thermoplastic materials which may warp or melt at the curing temperature.

Thermosetting plastics are resistant to most commercial solvents, whereas thermoplastics vary greatly in their resistance to solvents. Accordingly, in the development of a paint for a particular thermoplastic material it is necessary to determine what solvents can be used safely. This limits the available resins to those soluble in the prescribed solvents. At this point it is necessary to determine the quality of the finish required for the application and attempt to formulate a resin system at the lowest possible cost.

Adhesion to the plastic is perhaps the most fundamental property and is a good place to start. The first step

is to prepare solutions of available resins in an appropriate solvent and test for adhesion. When resins with satisfactory adhesion are found, they are usually modified with other resins to obtain other desirable properties taking care, of course, to retain adhesion.

At least one component of the resin system must be a film-former, such as an alkyd, nitrocellulose, cellulose ester, cellulose ether, or polyvinyl. Other non-film forming resins or modifiers, of smaller molecular weight, may be used to modify the film-former for improved hardness, adhesion, gloss, and other such properties. The required properties will vary with the application. The following properties are required to meet certain automotive and refrigerator specifications:

1) Grease Resistance: One hundred hours in a 50-50 mixture of lard and oleic acid at room temperature with no appreciable softening of the coating or loss of adhesion.

2) Humidity Resistance: One thousand hours in a humidity cabinet at 110° F. and 100% relative humidity with no softening, blistering, or loss of adhesion.

3) Stain Resistance: Must not stain upon contact with orange juice, grapefruit juice, tomato juice, or perspiration for 48 hr. at room temperature.

4) Soap and Detergent Resistance: Twenty-four hours in a solution of mild soap or detergent at approximately 110° F. with no softening or loss of adhesion.

5) Accelerated Aging: One hundred sixty-eight hours at 158° F. without appreciable change.

6) Resistance to Temperature Changes: Twenty-five cycles at temperature variations from 0 to 80° F. with no cracking of the film or loss of adhesion.

7) Light Stability: A minimum of 100 hr. in the Atlas Fade-Ometer, or the equivalent.

8) Mar and Abrasion Resistance: Must withstand normal usage without scuffing, marking, or chipping.

9) Adhesion: "Scotch" tape adhesion of the film to the plastic surfaces.

Quality can be sacrificed for price in many applications. However, most plastics in use today are excellent products and the quality of the object should not be sacrificed because of a poor paint job.

The Solvent System: The solvent system will depend on a number of factors, such as the type of plastic to be painted, the resin system selected, and the method of application. In all cases the least volatile component, commonly called high-boiler, of the system must not etch the plastic surface severely and it is desirable that it give no visible etch. Even slight etch may disturb the surface of most thermoplastics, resulting in a poor paint film, particularly when used on the second surface of plastic. This is most important in vehicles for metallics and pigmented metallics where etch tends to affect the leafing of the metallic powder and cause color change. It is equally important that solvents do not craze or crack plastic.

The high-boiler must hold the resin in solution until the film is completely dry to assure a continuous smooth film. In a spray coating it is common practice to use a mixture of high-boiling and low-boiling solvents, balanced to give a low viscosity for spraying and a relatively higher viscosity when the film reaches the plastic surface. This is accomplished by selecting a low-boiling portion which will be blown away during the spray operation, thus increasing the solids content and in turn increasing the viscosity of the wet paint film laid down on the plastic. The amount of high-boiler in a spray paint must be adjusted carefully since it controls the viscosity of the wet film laid down on the surface. If the viscosity is too high, the film will orange peel. If it is too low, craters may develop and the paint will run away from corners and edges. Cobwebbing, common in certain spray formulations, can be controlled within limits by solvent or thinner adjustments.

Silk Screening

Silk screening merits special attention because of special problems involved. The solvent system in silk screening inks must be blanced to allow for slow drying and continued operation on the screen without sacrificing too much dry time on the painted surface. Most silk screening

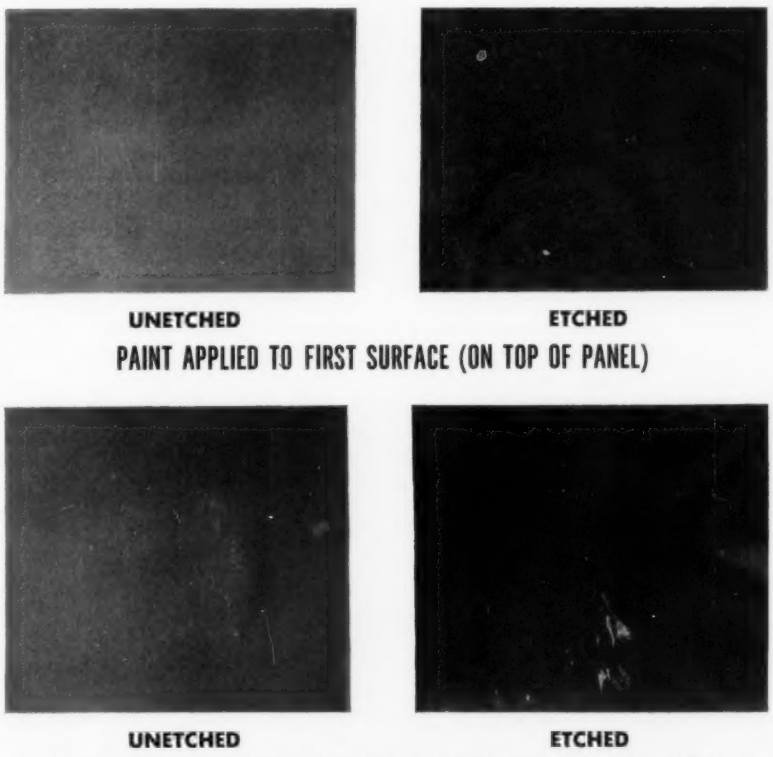
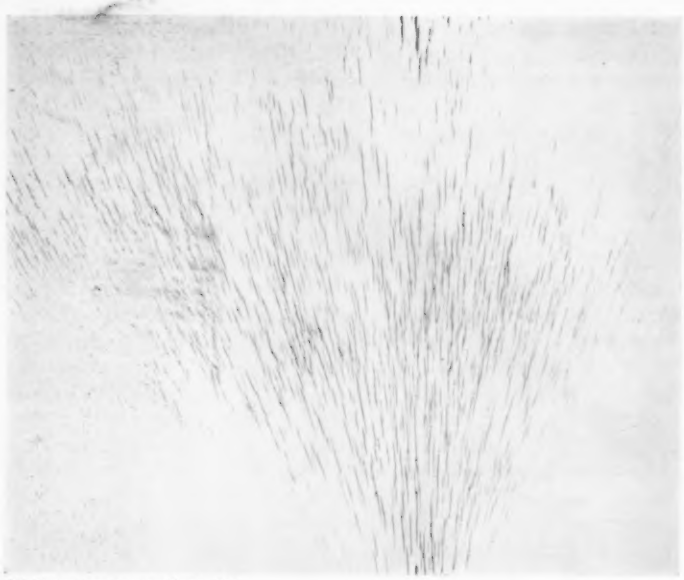


Fig. 4—Effect of etch of polystyrene on color of pigmented metallic paint



All illustrations courtesy Logo, Inc.

Fig. 5—Craze pattern on strained polystyrene part dipped in *n*-heptane

inks are prepared for use with no further thinning. However, experience has indicated that users prefer some latitude for thinning in order to allow for adjustments to meet particular requirements. In silk screening applications, wet films of the same thickness are always applied with a given gage of silk in the screen. It is important, therefore, that the solids content and the pigment-to-resin ratio be kept constant to assure a uniform thickness of the dry film. The solvent system must be adjusted for sufficient flow-out to cover screen pattern, but to avoid excessive running at the sacrifice of detail. There must be no stringing of the paint when the screen is pulled away from the plastic after inking, and there must be no bubbling.

Certain plastics such as highly plasticized vinyl, cellulose acetate, and cellulose acetate butyrate absorb certain solvents quite rapidly without visual effect on the plastic in the form of etch. Through-dry time of a paint film is lengthened considerably in such cases since the solvent must migrate back through the plastic and the paint film before it can evaporate. Parts screened with such a paint will appear dry, but upon packaging may stick together or to the package. Also, this removal of solvent from the film by absorption as well as by evaporation renders the film immobile very quickly, thus reducing flow-out and causing a severe screen pattern to remain in the film.

Dip formulations require a solvent balance to give good flow-out with minimum or no sagging. This is accomplished by allowing sufficient solvent to stay in the film long enough for flow-out, but maintaining a balance of evaporation to render the film immobile before it sags.

When the resin-solvent combination has been adjusted to meet the specified requirements, the vehicle is complete. To finish the paint, pigment must be dispersed into the system by use of a ball mill, a 3-roll mill, or some other intensive mixing and grinding device.

The Pigments: Pigments serve many functions in paint, but in this discussion of finishes for plastics, only pigments which are used for color will be considered.

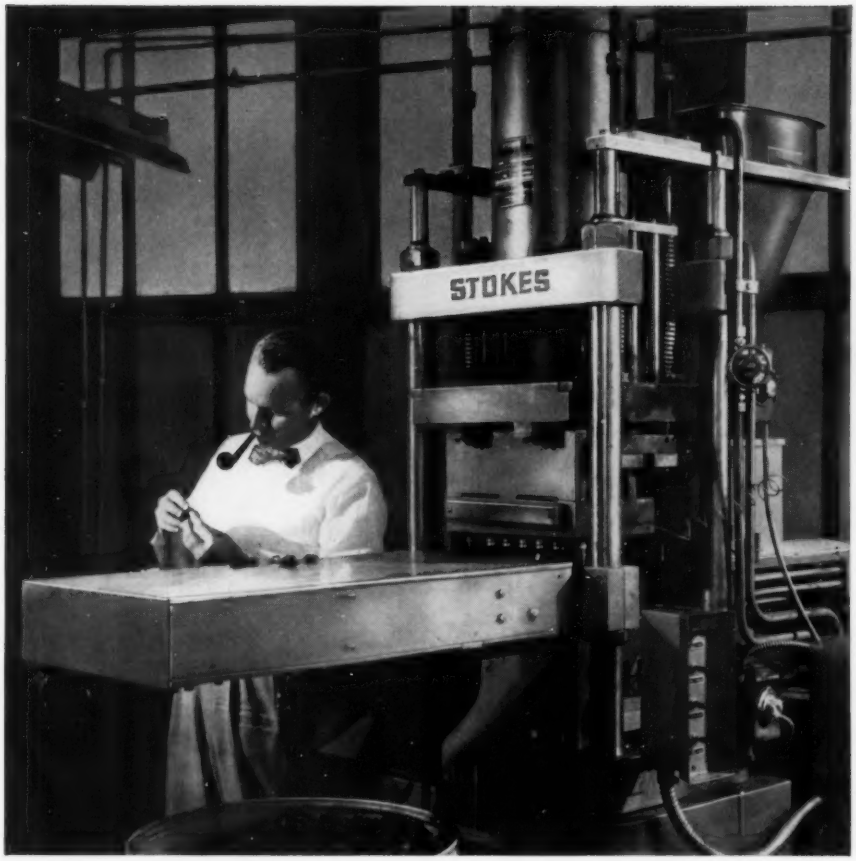
When light strikes a pigmented film of paint on a plastic surface, some of the light is absorbed and converted to heat, some is reflected, and some may pass through the film as transmitted light if the plastic is clear. If the pigment selectively absorbs a certain wave band of light and converts it to heat, the remainder of the light will be reflected back to the eye, or transmitted through the film to the eye. This light, minus the absorbed portion, will have color and the color will depend on the particular wave band absorbed. For example, if a pigment absorbs the red, yellow, and green portions of the spectrum, it will reflect the remaining blue visible band.

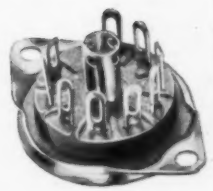
Reflection of light from a pigmented surface is responsible for the covering power of the pigment and depends on the difference in the refractive indices of the resin binder and the pigment. If the difference is great, the light will be bent accordingly when it passes successively from the resin binder into pigment particles and back to the resin binder. Most of the unabsorbed visible light will be returned to the surface film and back to the eye. Such pigments cover well and are classified as opaque. If, on the other hand, the resin binder and the pigment have the same refractive index, the unabsorbed light will pass through the film unbent. Such pigments have no covering power and are classified as transparent.

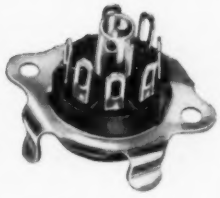
Paint for outdoor durability, as required by the display sign and automotive industries, requires light-stable pigments and vehicles. Such pigments as non-chalking rutile titanium dioxide white, carbon black, and iron oxides have good light stability. Except for phthalocyanine and indanthrene colors, few organic toners have good light stability in tint tones.

Many other organic pigments such as toluidine red, Hansa yellow, and B.O.N. maroons have good light stability in the mass tone but tend to fade when mixed with titanium dioxide. Light stability may be sacrificed when such pigments are blended in color matches.

Bleeding: The tendency for a paint pigment to migrate from one film to another, thus causing difficulty where two different colors contact one another or where one paint film is painted over another, is called "bleeding." For example, in second surface painting of clear plastic, white may be used to paint an area in the center of a panel and the entire panel backed-up with, say, red to give the effect of white showing against a red background when viewed through the plastic. In such an application a bleeding red will migrate through the white, changing it to a pinkish color (Fig. 1, p. 99). Small molecular weight organic pigments and soluble dyes are bad bleeders and must be used with caution. There are many instances where dyes and bleeding pigments







This Model 741 Stokes automatic molding press operates 24 hours a day, Saturdays and Sundays included, at Mandex Manufacturing Company, Chicago. Typical sockets of general-purpose black and mica-filled phenolic are shown above.

Cost of plastic part cut 80% on STOKES automatic molding press

With a Stokes Model 741 press, Mandex Manufacturing Company of Chicago has cut the cost of a typical plastic socket used in their electronic components by 80%.

Operation of the Stokes press at Mandex is typical of the way many manufacturers take advantage of the economies of fully automatic plastics molding; the press runs 24 hours a day, Saturdays and Sundays included. All that's needed is molding powder; the oversize hopper, enough for a day's production, is filled by the night watchman. The only other attention the machine receives is periodic inspection by a maintenance specialist.

Stokes fully automatic molding presses offer startling economies over semi-automatic operation. *Positive mechanical ejection* is an essential feature of fully automatic operation — no reliance is placed on air knock-out — and safety controls arrest operation instantly in case of any interruption to the cycle.

Stokes' unequalled experience in the design and application of automatic plastics molding equipment can help you. Write for your free copy of a brochure, "Fully Automatic Compression and Injection Plastics Molding" which contains many typical cost-cutting case histories. For full information on the Stokes 741 automatic press, write for Bulletin 506; on other Stokes presses for Bulletin 526.

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ENGINEERS: Stokes is continually adding to its technical sales staffs in the high vacuum, industrial tabletting, powder metals and plastics molding fields. If you can qualify, there may be a position for you.

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are definitely useful and cause no trouble; therefore, it is important to know the exact application of paint in order to determine whether such a certain pigment can be used to obtain a specified color.

To avoid reactive combinations, pigments must be selected with a thorough knowledge of the vehicle and pigments. Basic pigments such as barium or calcium lithol and zinc oxide may be reactive with certain vehicles having high acid values. Such combinations will gel on standing, making the paint unusable.

Metallic powders such as aluminum and bronze are commonly used as pigments. The bronze in particular is quite reactive and has a very limited shelf-life in most vehicles. Usually, to avoid gelation, it is necessary to mix the required amount of bronze powder immediately prior to use. Again, there are exceptions. There are a few special vehicles for use on plastics which will tolerate bronze powder over a long period of time with no gelling.

For optimum results each particle of pigment must be coated with vehicle, thus separating it from all other pigment particles in the dispersion. They must then be enclosed in a sort of resin envelope when laid down as a film. If the pigment-to-resin ratio is too high, the pigment particles will protrude from the film, thus breaking up the reflected light, resulting in poor gloss (Fig. 2, p. 100). When flat or mat finishes are required, it is much cheaper to add inert pigments such as diatomaceous earth or silicates, rather than the more expensive colored pigment, to break up the light.

With the correct pigment dispersed in the correct vehicle we have a paint for use on a particular plastic, and can turn to problems involved in its application.

Problems in Operation

Humidity Blush: Humidity blush may be demonstrated by the series of sketches in Fig. 3, p. 100. Two wet samples of paint may look exactly alike in the can even though one may have excellent humidity blush resistance.

Sketches A1 and B1 are presented as cross sections of freshly sprayed films which are still homogeneous. Sketches A2 and B2 simulate cross sections of the film after considerable solvent has evaporated; film A2

Fig. 6—Paint film with "orange peel"

is still homogenous, but B2 has begun to curdle or blush. In extreme cases blush may appear immediately upon spraying. Hard film A3 is continuous. It will have adhesion to the plastic and should gloss well. Film B3 is discontinuous and spongy. It will have poor adhesion to the plastic and will have no gloss as a result of severe humidity blush.

Occasionally, slight humidity blush will cause loss of adhesion with practically no change in the appearance of the film beyond a slight loss of gloss. For this reason, adhesion is the best quality control check for this type of failure. This is particularly true when working with flat paints.

Humidity blush is the result of water which condenses from the atmosphere as paint is sprayed and as solvents evaporate from the paint film. At a point, the water-solvent mixture becomes such a poor solvent that the resins are thrown out of solution, forming discrete particles of resin which do not adhere to one another or to the plastic surface when the film is dry. Several factors contribute to humidity blush and must be considered in its control.

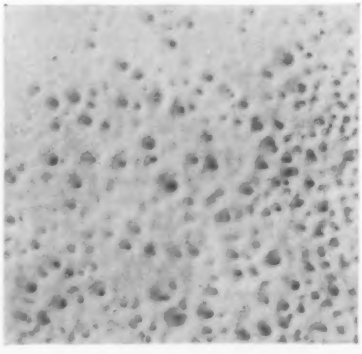


Fig. 7—Paint film with craters

Spray finishes are reduced to spray-viscosity with thinners containing low-boiler in order that much of it can be blown away, thus allowing a paint film of much higher viscosity to reach the plastic surface. The evaporation of thinner between the spray nozzle and the surface being painted effectively removes heat from the area, thus reducing the temperature of the air and causing moisture condensation. This continues as solvents evaporate from the wet film. The amount of heat removed is a function of the latent heat of vaporization of the solvents.

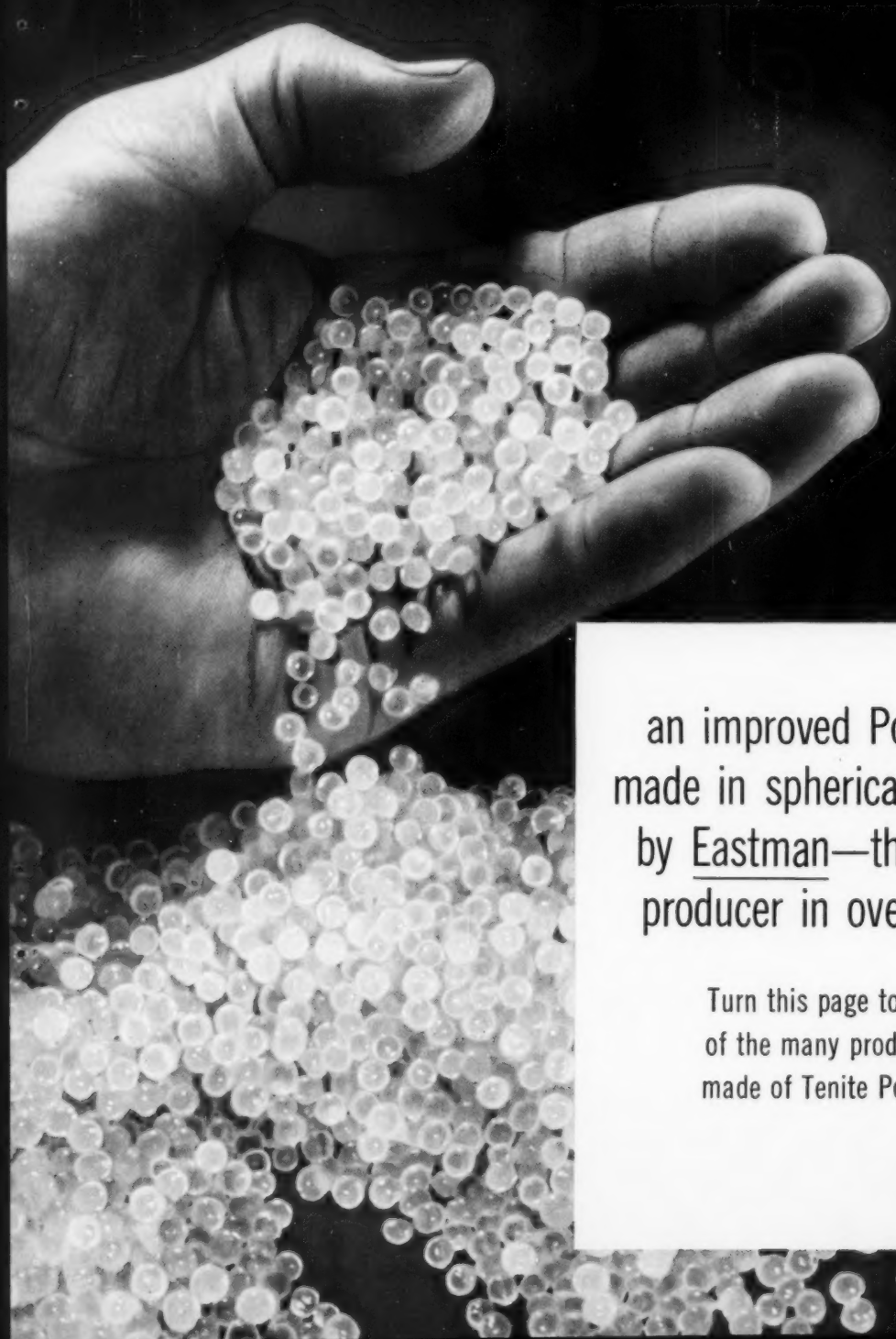
Resins of the paint system are much more likely to be thrown out of solution by condensed moisture, if the solvents remaining in the wet paint film have a significant tolerance for water. Within limits, moisture can be removed from the paint film by solvents which form azeotropes with the water, and in some cases small amounts of water can be removed fast and effectively enough to avoid precipitation of the resin and resultant blush.

The effectiveness of the solvent for the resin system has a direct bearing on blush. Border-line solvent systems will require only a small amount of water to throw the resins out of solution; a stronger solvent system will require considerably more water. The activity of the solvent system toward the plastic is also affected by the presence of water. Accordingly, it is often desirable to use a more active solvent system when the humidity is high in order to hold the resins in solution and use a less active solvent system when the humidity is low in order to avoid etching the plastic. This may be handled by a change of thinners.

Etch: Certain solvents attack or bite into thermoplastic surfaces, leaving a roughened or frost-like condition called "etch." Many finishes for thermoplastics depend on etch for adhesion. However, it has been demonstrated that visible etch is not always necessary, and should be avoided when possible in order that parts may be cleaned of overspray without affecting the appearance of the plastic. In the case of plastics containing plasticizer and in other special cases where the resin in the paint has physical and chemical properties closely approximating that of the plastic itself, it is difficult

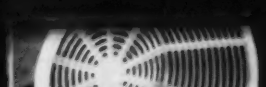
(*To page* 109)

This is
TENITE POLYETHYLENE



an improved Polyethylene made in spherical pellet form by Eastman—the first new producer in over 10 years

Turn this page to see some of the many products being made of Tenite Polyethylene



TOUGH, COLORFUL KITCHENWARE

1. **Pail. 2. Juice Container. 3. Food Strainer,** Dapol Plastics, Inc., Worcester 5, Mass.
4. **Food Freezer Boxes,** Central Home Products, Syracuse, N. Y. Molded by Ontario Plastics Co., Rochester, N. Y.
5. **Juicer,** Falcon Plastic Products Mfg. Co., Culver City, Calif.

Will TENITE POLYETHYLENE mean faster sales for your line?

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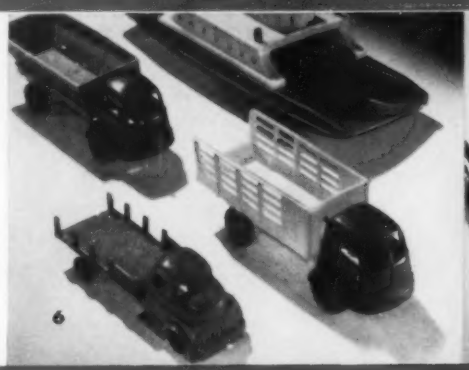
7. **Rodeo Toys,** Archer Plastics Co., Woodside, N. Y. Molded by Almor Plastics Corp., Elmhurst 73, N. Y.
8. **Sand Buckets,** Thomas Mfg. Corp., Newark 5, N. J.
9. **Play Hats,** Actwell Toys, Inc., Hoboken, N. J.
10. **Truck and Tractor,** Processed Plastic Co., Aurora, Ill. Molded by Han-Win Products Co., Aurora, Ill.

Could TENITE POLYETHYLENE help your toys take harder knocks?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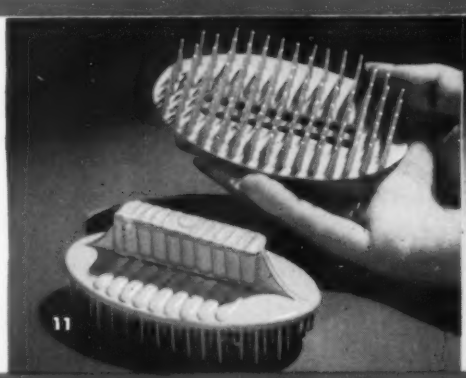
DURABLE, NON-CHIPPING HOUSEHOLD ITEMS

11. **Shampoo Brushes,** Thomas Mfg. Corp., Newark 5, N. J.
12. **Pitcher and Coasters,** Dapol Plastics, Inc., Worcester 5, Mass.
13. **Funnel,** Ontario Plastics Co., Rochester, N. Y.
14. **Toilet Seat Bumpers,** Plastiglide Mfg. Corp., Santa Monica, Calif.
15. **Ice Cube Trays,** Tremex Industries, Chicago, Ill. Molded by Anchor Plastics Co., Chicago, Ill.

Would TENITE POLYETHYLENE help your home products last longer?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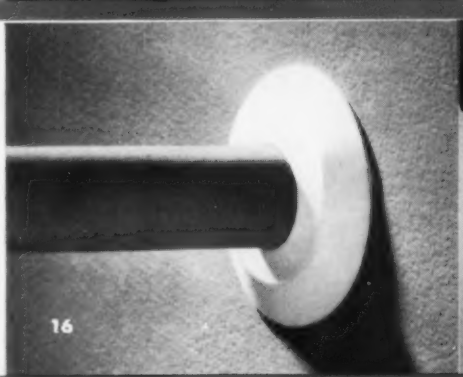
plus many other PROFITABLE IDEAS IN PLASTIC

16. **Pipe Flanges,** Falcon Plastic Products Mfg. Co., Culver City, Calif.
17. **Friction Catches,** Jaybee Mfg. Corp., Los Angeles 65, Calif. Molded by Plastiglide Mfg. Corp., Santa Monica, Calif.
18. **Ink Stoppers,** Neo-Line Products Corp., Woodhaven 21, N. Y.
19. **Bottle Caps,** Replicap Corp., Bradford, Ohio
20. **Lunch Box,** Dapol Plastics, Inc., Worcester 5, Mass.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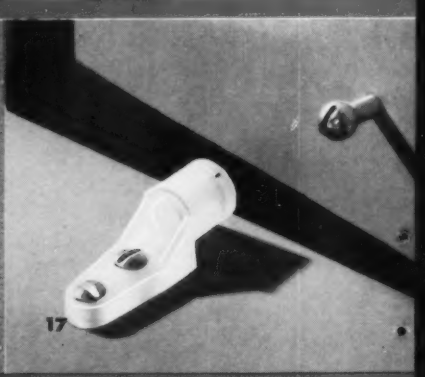
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21. **Syringe,** Delta Laboratories, Inglewood, Calif. Molded by Artcraft Plastic Moulders Ltd., Los Angeles, Calif.
22. **Red Heart Dog Feeding Dish,** Molded and distributed by Lind Plastic Products, Inc., Chicago, Ill., for The Red Heart Div. of John Morrell & Co., Chicago, Ill.
23. **Beverage Can Spout,** Berkshire Plastics Co., Inc., East Longmeadow, Mass.
24. **Practice Golf Balls,** Tigrett Industries, Chicago 11, Ill.

Can lightweight, corrosion-resisting TENITE POLYETHYLENE help you make some product better or simplify its production?

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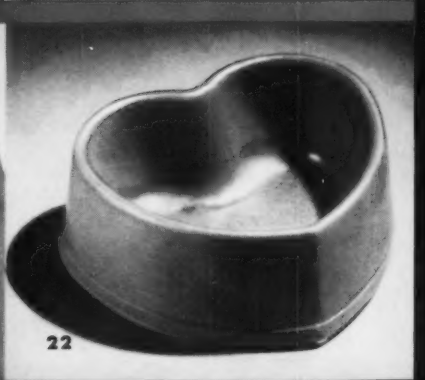
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TENITE

POLYETHYLENE

an Eastman plastic

Can Tenite Polyethylene add more sales appeal, better performance or longer life to the products you make?

Tenite Polyethylene is a plastic suited to many uses.

It is odorless and tasteless. It remains flexible over a wide temperature range and is virtually unbreakable. The lightest of all solid plastics, it saves weight in every application.

Tenite Polyethylene is tough — but soft enough not to scratch delicate surfaces.

Resilient, it resists permanent deformation and affords airtight seals for containers and closures, providing an effective barrier to moisture and odors.

At ordinary temperatures, Polyethylene resists the attack of most chemicals and solvents. It offers outstanding resistance to many severely corrosive liquids.

Tenite Polyethylene is easy to mold. Its resilience simplifies mold and core design. Undercut parts can be stripped easily from cores — a procedure which is extremely difficult with other rigid plastics.

To the inherent molding ease of this plastic, Tenite Polyethylene adds the many advantages of spherical pellet form. Spherical pellets flow freely through molding and extrusion machine hoppers. Their smooth, unbroken surfaces resist accumulation of dirt during storage and use. And, because there are fewer "fines," molders can clean hoppers quickly when changing colors.

Spherical pellets are space-savers, too — 1000 pounds of Tenite Polyethylene pellets can be shipped or stored in the same space needed for only 900 pounds of ordinary pellets.

Investigate Tenite Polyethylene as a new material for your use. It is available for injection molding, blowing or continuous extrusion in a wide variety of colors and colored concentrates.

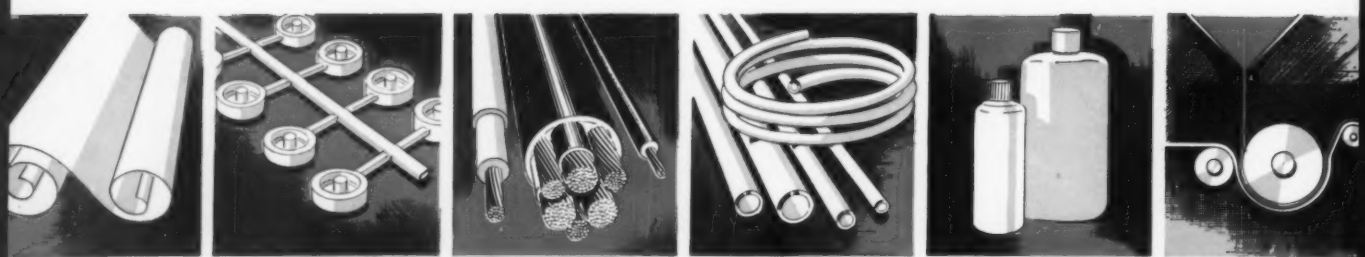
Eastman, the manufacturer of Tenite Polyethylene, is one of the pioneers in plastics. As a leading producer of the thermoplastic cellulosics, Tenite Acetate and Tenite Butyrate, Eastman brings over 20 years' experience to users of Tenite Polyethylene — another thermoplastic material. So look to Eastman for the help you need in designing plastic products made of Polyethylene. Your molder or molding department can tell you more about the quality of Eastman plastics and the technical service which backs them up.

For more information on Tenite Polyethylene and help in adapting the many advantages of this versatile plastic to your product needs, write to EASTMAN CHEMICAL PRODUCTS, INC., a subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

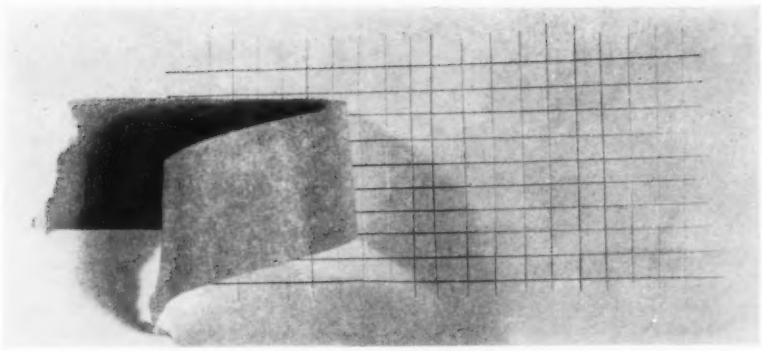
. . .

Information regarding Tenite Polyethylene also can be obtained from local representatives listed under "Plastics—Tenite" in the classified telephone directories of the following cities: Chicago, Cleveland, Dayton, Detroit, Houston, Leominster (Mass.), Los Angeles, New York City, Portland (Ore.), Rochester (N. Y.), St. Louis, San Francisco, Seattle and Toronto—elsewhere throughout the world, from Eastman Kodak Company affiliates and distributors.

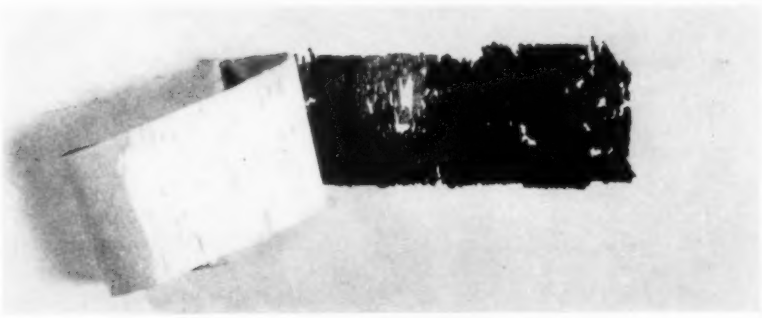
TENITE
POLYETHYLENE
an Eastman plastic



POLYETHYLENE APPLICATIONS INCLUDE packaging film . . . molded products . . . wire and cable insulation . . . pipe and tubing . . . bottles . . . paper coatings



GOOD ADHESION



POOR ADHESION

Fig. 8—Determining paint adhesion by "tape test" method

to avoid the use of solvents which will etch.

Even the slightest etch may show up when clear parts are painted on the second surface. Considerably more etch can be tolerated when painting the first surface, since the paint will tend to cover the etch with no deleterious effect on the film surface. Severe etch is often accompanied by a color change as in Fig. 4, p. 101. Pigmented metallics (formulated with pigment and aluminum powder) which have severely etched the plastic surface, look darker than normal when viewed through the plastic and more nearly like aluminum when viewed on the surface; the pigment tends to soak into the plastic, leaving the aluminum on the surface.

The addition of inactive thinners to active paints may reduce or eliminate etch. However, inactive solvents must be added with care to avoid throwing resins out of solution in a manner similar to that resulting in humidity blush.

Paints are generally less active toward thermoplastics and tend to etch less under conditions of high humidity. This is a case of water reducing the activity of the solvent and is particularly noticeable when the solvent system that is being used exhibits a fair degree of miscibility with water.

Crazing: Crazing of plastic is a result of internal or surface stresses set up when the part is machined, flexed, shocked by impact, subjected to abrupt and uneven changes in temperature, or subjected to the action of certain solvents. It occurs in the form of distinct surface cracks or minute frost-like internal cracks when these stresses exceed the tensile strength characteristics of the plastic material.

When local stresses are present, but are less than the tensile strength of the plastic, the area is under strain. Certain plastic parts, which look perfectly sound when molded, may be under strain and crack or craze at a later time in the painting or molding operation or even after being put into use.

Well molded parts are relatively free of strain and can be painted quite easily without crazing, whereas improperly molded parts may be so highly strained that they craze on cooling. Other molded parts may cool free of cracks but exist in a strained condition. When paint solvents are added to the surface of such strained parts, they will craze if the local stresses present, plus the added stresses due to solvent swelling, exceed the tensile strength of the plastic.

Sometimes *n*-heptane is used to determine the amount of strain in polystyrene. If parts craze when dipped in *n*-heptane, they are considered strained and unsatisfactory (see Fig. 5, p. 102). If they do not craze when dipped in *n*-heptane, they are relatively free of strain and are satisfactory.

Within limits, the addition of less active solvents to the paint system, or the replacement of the active solvent with less active, will reduce the amount of solvent absorbed by the plastic and eliminate crazing. The strain, however, will remain and the parts may crack later in assembly or in subsequent use. There are cases of extreme strain where almost any solvent, even water, may craze parts.

Occasionally, under conditions of high strain, solvents active enough to cause etch can sometimes be used without crazing. It is presumed that such solvents are absorbed rapidly and uniformly with such a degree of solvation that surface strain is relieved.

In one field operation, large polystyrene parts were highly strained in vacuum forming. The strain was of such a nature that the parts crazed and became quite brittle when painted with standard inactive paints. A little experimenting showed that they could be crazed by straight alcohol. On the other hand, the parts did not craze when sprayed with a material much more active toward polystyrene. It is presumed that the much more active solvent soaked into the plastic uniformly and with such a degree of solvation that the strain was relieved without rupture of the plastic. Such active finishes normally cause etch and are undesirable for general use.

Most molding powders are controlled carefully in production and are quite uniform. However, there are certain variations that may cause trouble. Plastics are high polymers and the average polymer size is usually controlled by blending batches of high and low polymers;

(*To page* 207)

Temperature and Pressure Measurements in

The Injection Machine Heating Cylinder

by C. E. BEYER*, R. B. DAHL*, and R. B. McKEE*

The accompanying article is the second of a series of three papers dealing with fundamentals affecting the injection molding machine so far as the heating cylinder is concerned. These three papers were presented at the 11th Annual Technical Conference of the Society of Plastics Engineers, Inc. The first paper, published in the Plastics Engineering department of *Modern Plastics* in the April 1955 issue, gave details on experimental work in determining temperatures and pressure drop. The present article treats with temperature variations in the heating cylinder. The third, to be published in the June issue, will consider the effect of design factors on heating cylinder performance.

DURING the past several years the importance of making quantitative measurements on the heating cylinder of an injection molding machine has become more and more apparent. One of the simplest and most direct measurements is the temperature of the plastic. This paper discusses a method of making such measurements conveniently and details some of the experimental results obtained by this method. The flow characteristics found with various heating cylinders are also discussed.

Apparatus

Of the several possible methods of measuring temperature, thermocouples were chosen as best under existing conditions. After several initial failures, a thermocouple of sufficient rigidity, strength, and accuracy was developed. This couple, mounted in the nozzle of the machine so that the plastic material flows around it, can be used either while purging the machine or when molding.

The thermocouple consists of #24 iron-constantan wires placed in a ⅛-in. stainless steel tube with the junction exposed through a small hole in the side of the tube and flush with the tube wall. The tube is filled with Sauriesen cement which holds the couple in place and strengthens the tube. The filled tube is then baked at 250° F. for 24 hours. A terminal block is mounted on one end for convenience in making connections.

This thermocouple can be mounted in any nozzle of standard design. A nozzle opening of 1 in. is desirable, but on small machines a ½-in. I.D. is acceptable. The thermocouple tube extends through the nozzle and is clamped in place, Teflon bushings being used as packing glands. These bushings permit easy positioning of the junction. To eliminate heat conduction errors, the nozzle heater is adjusted so that the temperature is not more than 10° F. below that of the plastic, the temperature being measured by another thermocouple

*Plastics Basic Research Laboratory, The Dow Chemical Co., Midland, Mich.

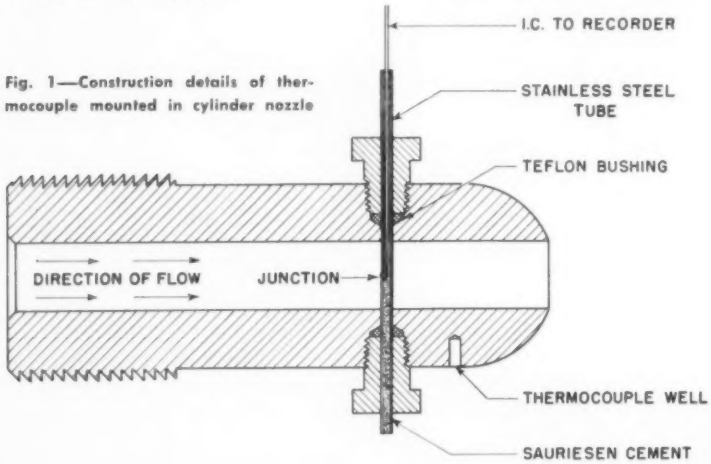
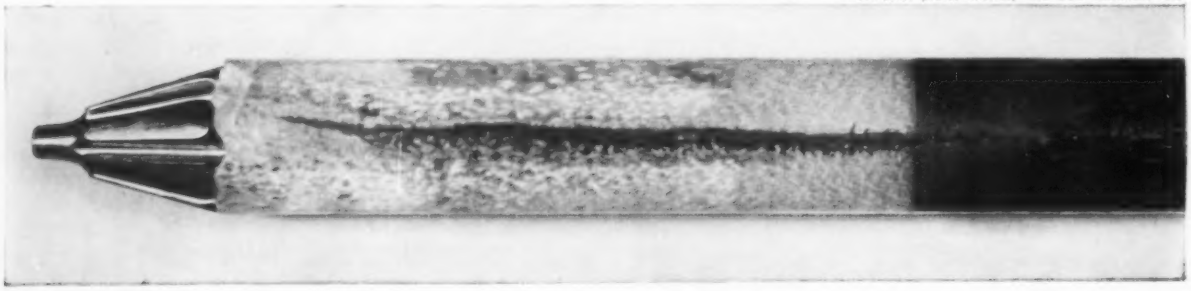


Fig. 1—Construction details of thermocouple mounted in cylinder nozzle

Fig. 2—Injection machine spreader with plastic material around it, showing pattern of material flow in cylinder

Four-color plates courtesy The Dow Chemical Co.



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> SURFEX® MM—Particle size: 1 to 5 microns. Resin coated. Oil absorption 20-22 cc per 100 grams.

> SUSPENSO®—Particle size: 1 to 5 microns. Uncoated. Oil absorption 20-22 cc per 100 grams.

> KALITE®—Particle size: about 1 micron. Oil absorption 28-32 cc per 100 grams.

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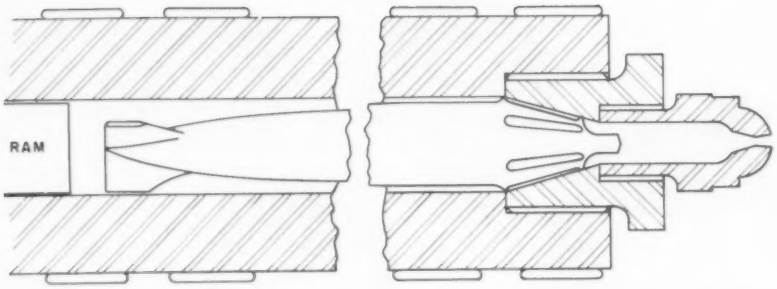

Fig. 3—Heating cylinder used to conduct flow pattern tests described on page 114

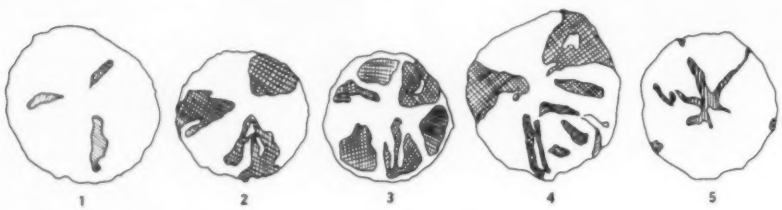

Fig. 4—Wafers cut from rod extruded on cylinder above show flow pattern around spreader

⅛ in. deep mounted in a well on the side of the nozzle. Details of this nozzle are shown schematically in Fig. 1, p. 110.

The junction of the thermocouple inside the nozzle is placed 0.6 of the radius from the center. This point was determined by considering the flow and temperature distribution in the nozzle. The temperature reading at this point approximates the average temperature along that radius. The thermocouple junction is then moved in a circle by rotating the nozzle, and temperatures are measured at various intervals. This circular traverse gives information about the flow pattern and temperature distribution. This temperature distribution, appropriately averaged, can be used to determine the heating capacity of the injection machine heating cylinder.

Flow Pattern

The manner in which the plastic material flows through the cylinder influences the heating efficiency. The radial velocity profile of an ordinary viscous liquid flowing through an annular ring, such as is found between the heating cylinder walls and spreader, would be parabolic in shape. The velocity profile of plastic flowing through the heating cylinder, however, is not of that shape. Most high polymers are composed of long chain molecules which in their normal unstrained state are kinked and coiled up into small balls. The stress applied to these molecules, near the wall of the cylinder, is very high and tends to orient the molecular chains in the direction of flow. In the oriented state the molecules slip past one another more easily and the viscosity at the wall drops. The result is a flow pattern which we refer to as "plug flow," in which most of the polymer flows through the cylinder at the same velocity.

Plug flow allows each small area of material to move forward at approximately the same rate so that most of the plastic emerges from the nozzle in approximately the same elapsed time. To show how plastic flows through the cylinder, successive shots of yellow, red, and green material were fed into the cylinder. As soon as the yellow appeared at the nozzle, the machine was stopped and the cylinder allowed to cool. The spreader with the plastic around it was removed and is shown in Fig. 2, p. 110.

This indicates that the bulk of the material stays together, except for that passing close to the guide fins, which extend out almost to the cylinder wall and are hotter than the rest of the spreader. As a result, plastic passing close to the guide fins is more fluid than the surrounding material. Thus there is faster flow in the fin region, which gives the effect of a hole in the almost solid compacted granular material. The amount of material jetting down the side has been calculated to constitute approximately 10 to 15% of the total shot weight.

Since cooling the cylinder and removing the spreader with the plastic

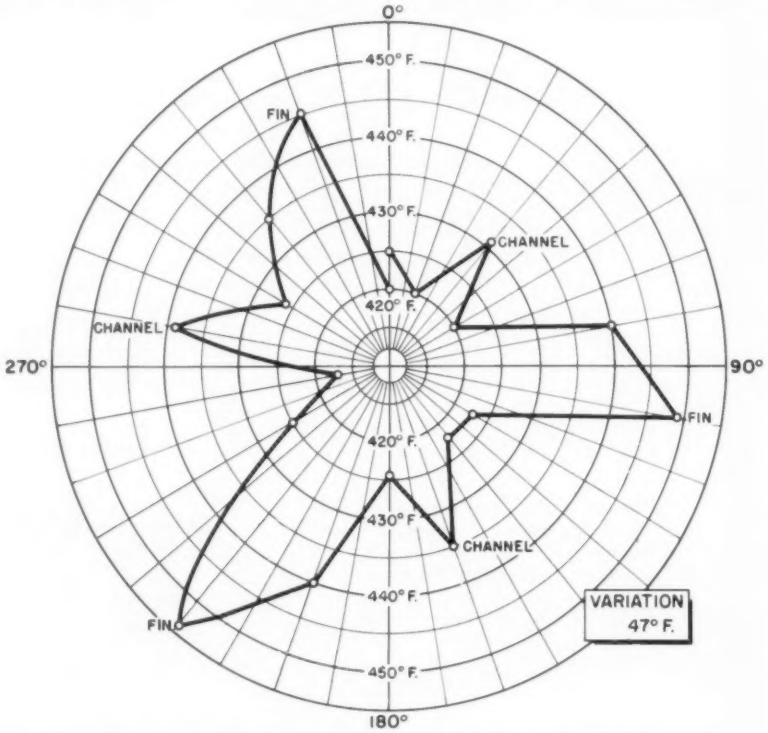

Fig. 5—Thermocouple record of temperatures of material passing by cylinder fins

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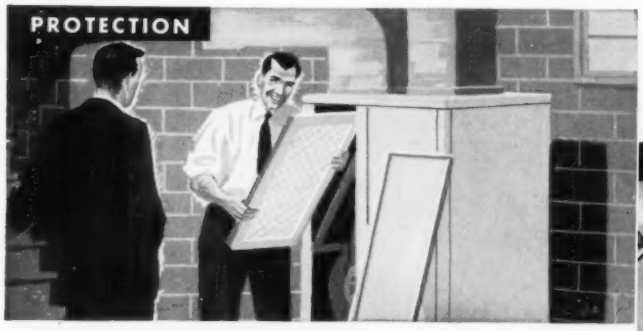

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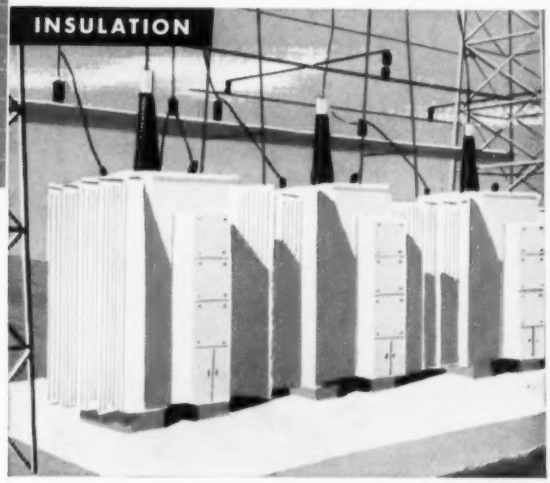

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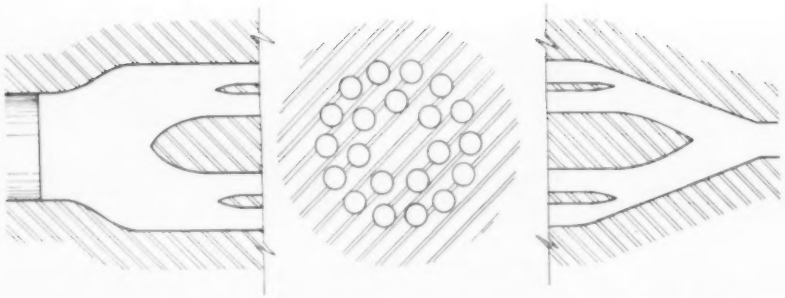

Fig. 6—Variation of cylinder for flow pattern tests has 21 concentrically spaced holes

shot capacity of the machine. The measured temperatures are shown in Fig. 5. Even after passing completely through the cylinder, which would allow time for some of the heat to be dissipated into the cooler plastic, the temperature directly downstream from the fins was 40 to 45° F. higher than the rest of the material coming out of the nozzle. It can be

(*To page* 119)

intact is a difficult job, a simpler method was devised to study the flow pattern around any spreader. The machine is first purged on a given cycle using clear plastic. One shot of dark-colored material is then introduced into the feed, followed by successive shots of clear plastic. The material extruded from the nozzle is saved and allowed to cool. Cross-sectional wafers are cut in the cooled material at various intervals and then examined.

This work was performed on the heating cylinder shown in Fig. 3, in which the spreader makes contact with the cylinder body at the forward end where the plastic flows through six channels into the nozzle. At the rear there are three guide fins extending to within ⅛ in. of the wall. With this cylinder the color first appeared along the fin streams. The colored areas gradually increased in size until most of the cross-section of the extruded rod was colored.

Figure 4 shows photos of wafers taken at various intervals along the extruded rod. Most of the material is moving forward in a solid mass except for that which is jetting down the sides ahead of the fins. The wafers show that after the main mass of colored material has passed through the cylinder there is still a trail of it coming out which has been trapped somewhere along its path. The six streaks show that it was held up at the entrance to the six holes.

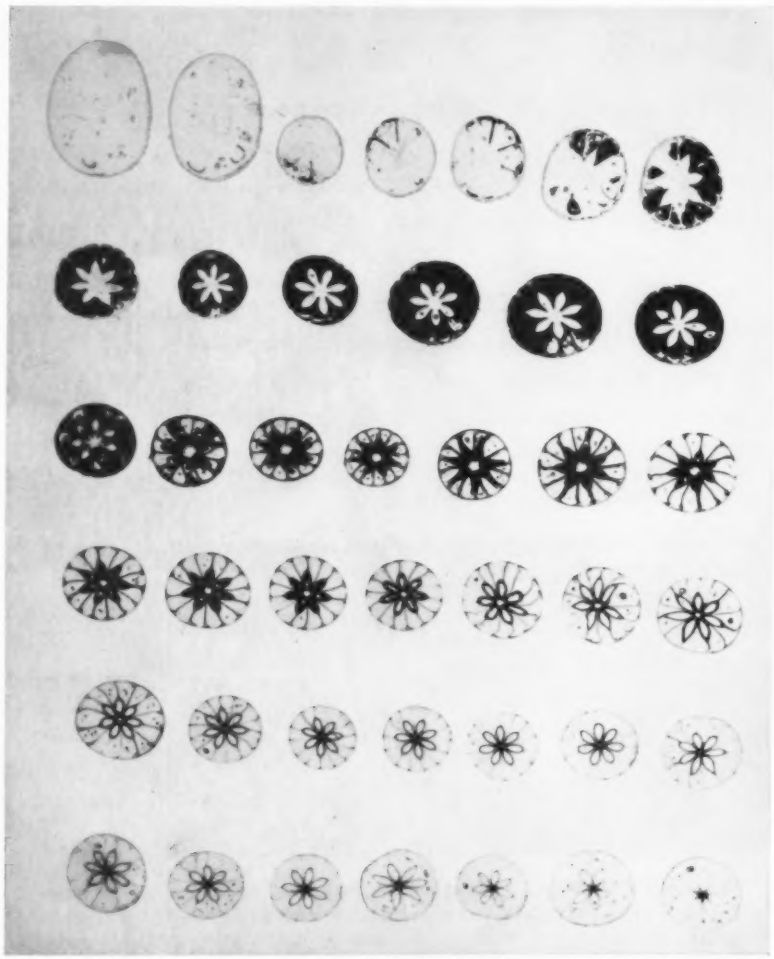

Fig. 7—Flow patterns on wafers cut from rod extruded from cylinder shown in Fig. 6

Temperature Differences

To observe whether the material passing by the fins was actually warmer, the thermocouple described previously was used and the nozzle was rotated through 360°, temperature readings being taken at 20° intervals. The temperature control was set at 500° F. and the machine operated on a 1-min. cycle using the rated

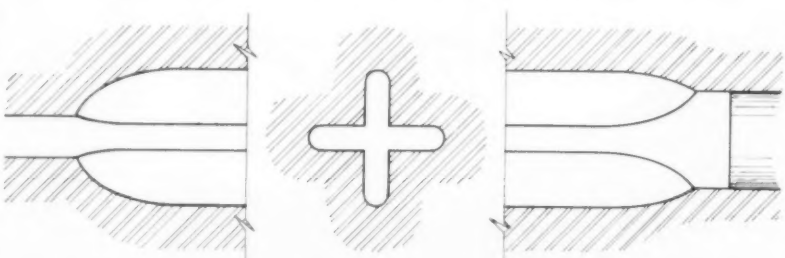

Fig. 8—Still another design for a cylinder used in testing flow pattern of molding material. In this case cylinder incorporates two slots cut at right angles to each other

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Handle for the "Sunbeam" Automatic Fry Pan molded by
Chicago Molded Products Corp., Chicago 51, Ill.

The handle for this automatic fry pan also houses the control element, so it requires a material that combines good appearance with superior molding qualities.

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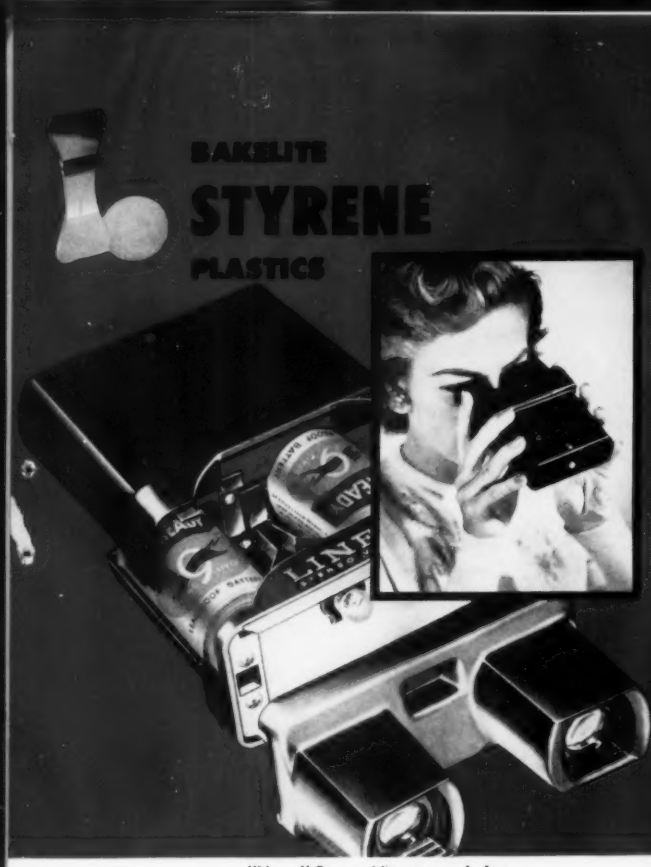

"Linex" Stereo Viewer made by
Linex Division of the Lionel Corp., Irvington, N. J.

A stereo viewer takes a lot of handling when slides are changed and it's passed around. Sometimes it's taken apart to change bulbs or batteries. In addition, it has to have a quality appearance.

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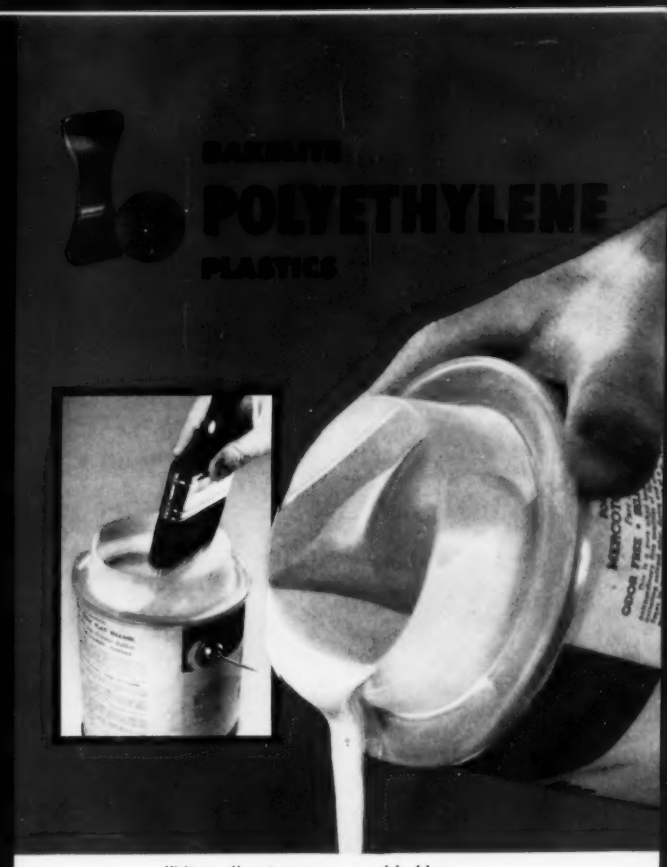
The high plasticity of TMD-5151 results in the fastest set-up speed available in a high-impact styrene —another reason why it's so popular with molders.



"Nomus" paint can top molded by
Rainbow Plastic Products Co., Minneapolis 16, Minn.

Molding this paint can collar of BAKELITE Brand Polyethylene provides several practical benefits. Inherent flexibility makes it easy to attach or remove. Accurate molding assures a tight fit. Paint won't harm it.

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concluded from this work that while fins are necessary in this type of design and are effective in supplying some heat to the spreader, they have a tendency to decrease the uniformity of the temperature as well as that of the flow pattern of the material going through it.

Similar experiments were conducted with cylinders of radically different design. The cylinder shown in cross-section in Fig. 6 consists of 21 holes in two concentric circles with 14 located near the outer surface and 7 in the center. The flow pattern of this cylinder is shown by the wafers in Fig. 7. When the colored shot was introduced and followed by successive shots of clear material, the colored material came through the 14 outer holes first as shown by the top two rows of wafers. The previous clear material formed a petal pattern in the center holes. The following two rows show the colored material starting to come through the center seven holes, with the outer holes beginning to clear up. The material is moving through the center holes slower than that in the outer holes. The temperature of the plastic material was found to be the same in all regions of the cylinder.

Figure 8 shows another cylinder with two slots cut at right angles. Cross-sections of wafers cut from the rod extruded from this cylinder are shown in Fig. 9. Here it can be seen that the highest rate of flow occurs in the center, with a lower rate of flow occurring at the bottom of the slots.

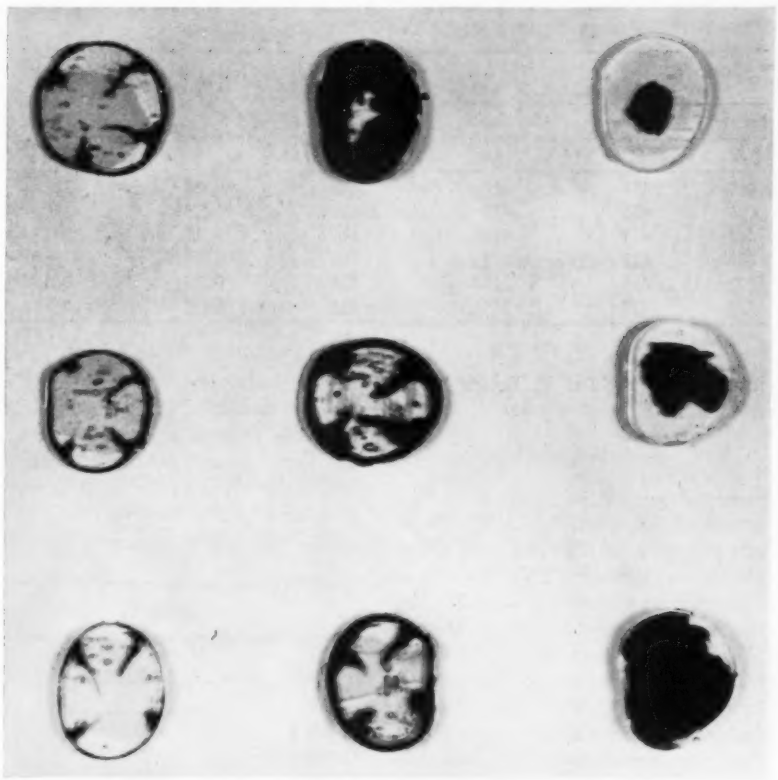

Fig. 9—Cross-sections of wafers cut from rod extruded from cylinder shown in Fig. 8, p. 114. Highest rate of flow occurs in center, lower rate at bottom of slots

Heater Effects

In observing molding operations, it is sometimes found that the heater settings on one machine vary as much as 50° F. Experiments were conducted to determine the effect which changing one of the three heaters would have on the temperature of the plastic extruded from the nozzle. This work was done at a plasticizing rate of 45 lb./hr. with all of the heaters originally set at 500° F. and the plastic temperature recorded. In three separate experiments, each heater (front, center, rear) setting was lowered in 25° steps down to 350° F., while the other two heaters remained set at 500° F. Actual cylinder temperatures were also measured at the various settings. The results of these meas-

Table I—Effect of Lowering Front Heater

Cylinder temperature			Average cylinder temperature	$\frac{T_a - T_o}{T_i - T_o}$	Plastic temperature
Front	Center	Rear			
°F.	°F.	°F.	°F.		°F.
476	502	476	485	0.794	400
462	489	472	475	0.797	394
440	491	467	466	0.786	384
413	475	461	450	0.778	367
388	463	459	437	0.790	361
368	459	460	429	0.783	352
349	455	458	421	0.786	347

Table II—Effect of Lowering Center Heater

Cylinder temperature			Average cylinder temperature	$\frac{T_a - T_o}{T_i - T_o}$	Plastic temperature
Front	Center	Rear			
°F.	°F.	°F.	°F.		°F.
485	477	469	477	0.805	399
479	453	459	464	0.806	389
493	429	456	459	0.800	382
486	406	448	447	0.799	372
491	410	459	453	0.784	371
481	395	453	446	0.796	370

Table III—Effect of Lowering Rear Heater

Cylinder temperature			Average cylinder temperature	$\frac{T_a - T_o}{T_t - T_o}$	Plastic temperature
Front	Center	Rear			
° F.	° F.	° F.	° F.		° F.
484	496	467	482	0.780	392
486	479	438	468	0.775	379
484	471	413	456	0.789	375
481	461	394	445	0.789	366
492	451	369	437	0.805	366
472	452	350	422	0.815	358

urements are given in Tables I, II, and III, p. 119 and above.

The $\frac{T_a - T_o}{T_t - T_o}$ ratio is the heating efficiency described in the first of this group of three articles, April MODERN PLASTICS, p. 127, where T_a is the plastic temperature, T_t is the average cylinder temperature, and T_o is the room temperature. The average plastic temperature dropped 53° F. while the average cylinder temperature dropped 64° F. In the cylinder design used in these experiments, the torpedo makes contact with the cylinder at the front and most of the heat in the torpedo comes from the front heater. With the front heater setting lowered (Table I) the temperature of the torpedo will be lowered, putting a greater burden on the center and rear heaters, which shows up in the drop in temperature of these sections of the cylinder. The center and rear heaters were not large enough to maintain the temperature set on the controllers under these conditions.

With the center heater setting lowered (Table II), the drop in average cylinder temperature was 31° F. and the plastic temperature 29° F. The center heater does not have much effect on the plastic temperature as heat is supplied to the center from both the rear and the front zones. For this reason, the center zone temperature could not be lowered farther than 395° F.

In lowering the rear heater setting, (Table III), the average cylinder temperature dropped 60° F. while the plastic temperature dropped 34° F.

The above experimental results

(To page 216)

Table VII—Heat Losses From Heating Cylinder

Type of shield	Plastic temperature	Output	Input	Heat loss
	°F.	B.t.u./hr.	B.t.u./hr.	B.t.u./hr.
No shield	400	6500	20,800	12,300
Aluminum foil	400	6500	15,080	6,580
Asbestos	400	6500	16,770	8,270
Asbestos and Aluminum	400	6500	15,400	6,900

Table IV—Machine Efficiency vs. Front Heater Temperature

Front Heater Temp.	Front	Center	Rear	Rate	Total input	Total output	Machine efficiency
° F.	B.t.u./hr.	B.t.u./hr.	B.t.u./hr.	#/hr.	B.t.u./hr.	B.t.u./hr.	Output/Input
400	0	2550	10,700	45	13,250	6470	0.49
450	1810	1650	11,150	45	14,610	6250	0.43
513	4150	360	11,400	45	15,910	6943	0.435

Table V—Machine Efficiency vs. Production Rate at 515° F. Control Temperature

Input			Total input	Plastic temperature	Rate	Output	Machine efficiency	$\frac{T_a - T_o}{T_t - T_o}$
Front	Center	Rear						
B.t.u./hr.	B.t.u./hr.	B.t.u./hr.	B.t.u./hr.	° F.	#/hr.	B.t.u./hr.	Output/Input	
4160	370	11,400	15,930	420	45	5,750	0.36	0.790
4500	1040	11,200	16,740	405	66	8,050	0.48	0.740
4350	1280	12,570	18,200	385	90	10,300	0.56	0.70

Table VI—Machine Efficiency vs. Production Rate at 615° F. Control Temperature

Input			Total input	Plastic temperature	Rate	Output	Machine efficiency	$\frac{T_a - T_o}{T_t - T_o}$
Front	Center	Rear						
B.t.u./hr.	B.t.u./hr.	B.t.u./hr.	B.t.u./hr.	° F.	#/hr.	B.t.u./hr.	Output/Input	
5750	800	15,210	21,760	500	45	7,090	0.33	0.785
6170	1920	15,900	23,990	470	69	10,100	0.42	0.735
6780	2320	15,730	24,830	445	92	12,600	0.51	0.685
7300	2950	15,220	25,470	400	139	16,700	0.66	0.585

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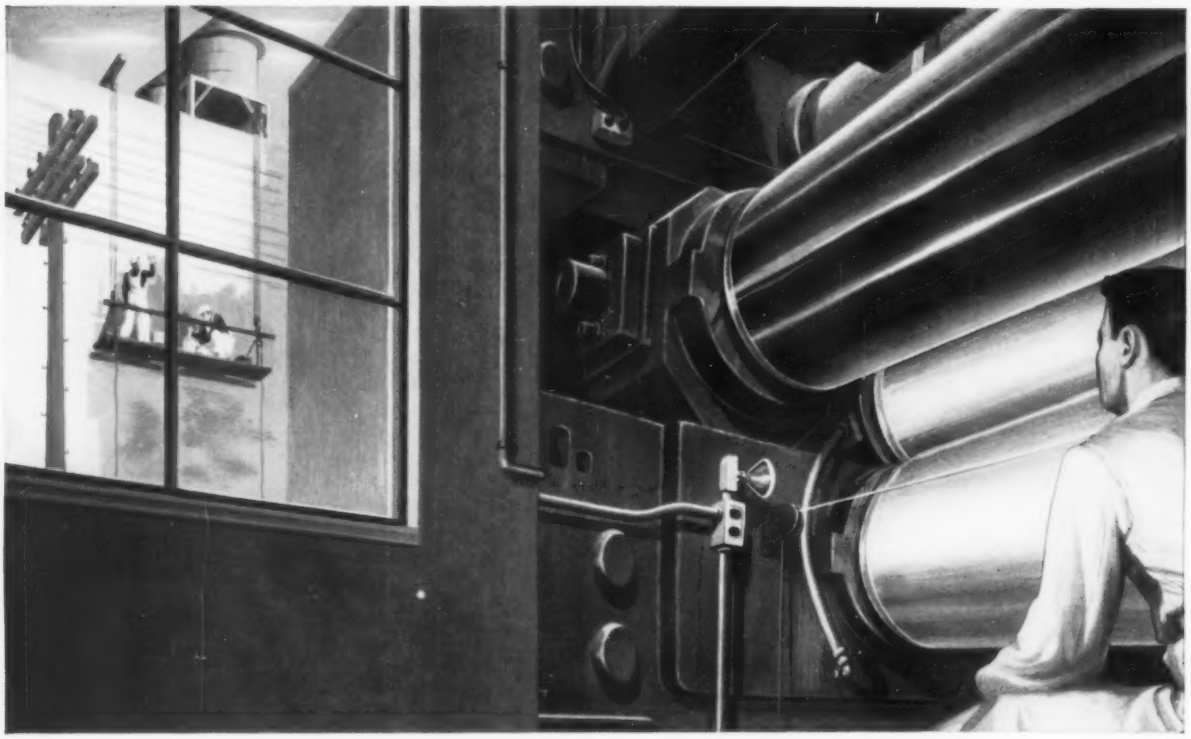

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PLASTICS*
TECHNICAL SECTION: Dr. Gordon M. Kline, Technical Editor

Hardness Testing of Plastics†

by BRYCE MAXWELL**

The indentation hardness of plastics has been studied in an attempt to explain some of the anomalies previously noted in these measurements, and to determine what physical constants of the material are responsible for resistance to indentation. Slow speed Rockwell-type tests are compared to high speed rebound-type tests. These results are interpreted in terms of the rheological properties of high polymers; specifically, the elastic modulus, yield point, plastic flow, elastic recovery, and delayed elastic recovery. The time and temperature dependency of the response of the material to hardness measurements is demonstrated. This investigation leads to the conclusion that each type of test gives some important data, but the values obtained or the relative ratings of materials shown by such tests should be used only after careful analysis of the test data from the point of view of the correlation of the test method with the conditions under which the materials in question will be applied.

THE hardness of materials is important to the design or applications engineer for two general reasons. On the one hand, he may be concerned with a problem where two bodies of different materials are being pushed against each other and he will need to know which will be deformed. On the other hand, he may be interested in the hardness of materials so that he can infer other properties from it. For example, there is a trend toward the assumption that the harder a material is the better will be its mar resistance.

Since hardness is not a fundamental engineering quantity it cannot be measured in fundamental units. All scales of hardness give relative values for materials; for example, the Mohs (1)[1] scale tells which among the very hard materials will scratch the other.

No investigation of the subject of hardness can be undertaken without first considering the definition of the term. It is not the object of this paper to attempt to delve too deeply into this question, but some discussion is necessary.

Each and every individual has some concept of the meaning of the word hardness, which is usually derived from experience. The difficulty arises in putting this concept into words. Many attempts have been made but none seems completely satisfactory. The dictionary gives us "solid and firm in substance and outline, not easily receiving indentation or impression." This may satisfy the layman but the technical man asks "what kind of indentation and how do we measure it? Is it the indentation produced by some specific indenter under some load or that indentation remaining after the removal of some specific load? What about the rate of indentation and the length of time we apply the indenter?"

Many devices for measuring hardness have been developed, but since the fundamental question of the definition has not been resolved the tendency has arisen to define the term hardness by the results of some particular test method. That is to say, the test determines the property rather than having the property determine the test. Much of the confusion about the subject of hardness can be laid to this situation. Coupled with this we have an increasing tendency to associate other properties of materials with hardness, as determined by certain specific tests, and to draw some inference about these properties from hardness measurements. An example is abrasion resistance. Many erroneous concepts can arise from this procedure.

It is the object of this paper to describe some investigations of the resistance of plastics to indentation. That is, for our purpose we shall define hardness as the resistance to indentation, but no stand will be taken on whether the indentation should be elastic or plastic as far as the definition is concerned. Indeed, it is our purpose to show that both types are important and that careful consideration should be given to each in the interpretation of test results and in the application of these results to engineering problems.

The standard test for hardness of plastics has developed from the Rockwell test for hardness of metals. Since plastics are generally considered to be softer than metals, a lighter load and a larger indenter are used. In order to overcome the tendency to cold flow during the test a rigid time cycle is applied. As a result of these modifications it is possible to test plastics on the same general piece of apparatus as is used for metals.

Another type of apparatus that has been quite popular in the metals field is the Scleroscope, in which the rebound of a small indenter falling on the specimen from a given height gives a measure of the hardness. It has been possible to correlate the results from this "dynamic" test when used on metals with the "static" Rockwell test. But when plastics are tested by this "dynamic" method, they give readings in some cases higher than hardened steel. This anomaly must be explained. Many attempts

* Reg. U. S. Pat. Off.

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** The Plastics Laboratory, Princeton University.

[1] Numbers in parentheses link to references at end of article, p. 136.

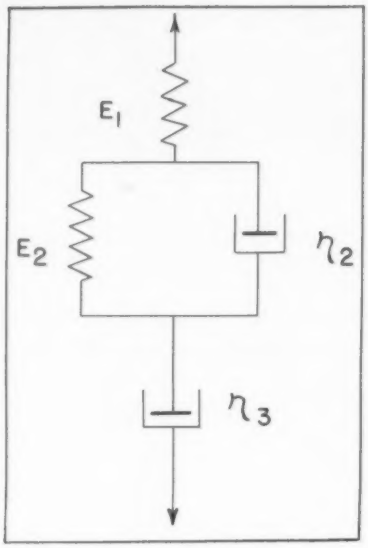

Fig. 1—Simple mechanical model showing behavior of high polymers

have been made but most seem to start with the preconceived idea that for all types of indentation metals should be more resistant than plastics. We shall attempt to show that this is not a valid assumption. First, let us consider briefly the response of a plastic to an applied mechanical force.

Basic Theory

The following description of the behavior of a plastic under applied mechanical stress is not intended to be complete. Only those general topics pertinent to this study are included (2).

When a mechanical stress is applied to a polymeric material, a deformation will take place which is dependent on the amount of the stress and the rate at which it is applied. If the stress is very small the deformation may be elastic, either Hookean or non-Hookean. This elastic deformation takes place instantly upon application of the stress and will recover immediately and completely upon removal of the stress. This type of deformation results in the bending of the bond angles in the polymer chain.

If the stress applied to the material is large enough and maintained long enough, delayed elastic deformation and plastic flow will take place. This corresponds to the chain uncoiling mechanism and chain-chain slipping. Both of these processes take time, hence the rate of applying the stress is important. If the load is applied rapidly it will reach a higher level before plastic flow takes place, since it takes time for the bonds between chain segments to reach the energy level required for breaking and reforming due to the combination of applied stress and thermal agitation.

If the deformation all takes place by the mechanism of chains uncoiling from their natural configurations, then the deformation is eventually recoverable upon removal of the applied stress. This recovery is time-dependent and again depends upon the individual bonds reaching the required activation energy due to thermal agitation. If some of the deformation is by the chain-chain slipping mechanism, we have a system analogous to viscous flow; that is, the deformation will continue as long as the stress is applied. Upon removal of the stress none of this type of deformation will recover.

The behavior described above can be represented by a mechanical model. Referring to Fig. 1, the spring E_1 corresponds to the ideal elastic deformation of the bending of the bond angles. The combined element of the spring E_2 and the dashpot η_2 in parallel represents the behavior of the chain uncoiling mechanism, and the dashpot η_3 represents the chain-chain slipping mechanism. This is an over-simplified model since today the retarded elastic element made up of E_2 and η_2 is generally considered to be a series of retarded elastic elements with different viscous and elastic constants. It is apparent that each of these elements behaves in a manner similar to the deformations of the various chain segments of the polymeric mass.

When as a function of time a load is applied to the mechanical model of Fig. 1, the spring E_1 deforms according to its constant or modulus. With time the Voigt model of E_2 and η_2 will deform. If the viscosity η_2 is very low and the rate of load application very slow, the behavior of this combined element will be essentially that of the spring E_2. But if the viscosity η_2 is high or the rate of load application is rapid, the dashpot will support the load and the deformation of this element will be small. The third element η_3 deforms at a constant rate with time for any given load. Hence, as the load is increased this element will flow at an increasing rate.

Keeping the above in mind, we would expect that if stress-strain curves were determined for a plastic material the shape of the curve would change with the rate of loading. Such is the case. In Fig. 2, below, we see that for slow rates of straining the material exhibits a low apparent modulus and a low apparent yield point. As the rate of load application is increased the apparent modulus increases, since there is less time for deformation in the viscous element η_2 (chain uncoiling) and η_3 (chain-chain slipping). Similarly, the apparent yield point increases with rate of load application, since deformation does not become apparent in η_3 until the time under load is large or the applied load great. If the rate of applying the load is high enough, there is less opportunity for viscous flow and the material exhibits more elastic behavior.

Let us now consider the recovery of the material and the model upon release of an applied load. If, using a ¼ in. diameter indenter on a specimen of ethyl cellulose, we apply a load suddenly to the material, or for that matter to the model of Fig. 1, we obtain an instantaneous deformation, A-B, in Fig. 3; if we keep the load applied for some time, further deformation, B-C, will take

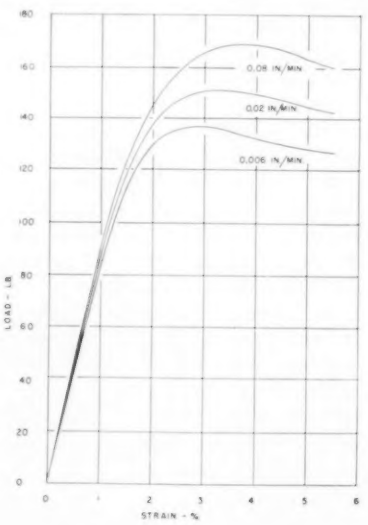

Fig. 2—Load-deformation curves obtained at various rates of straining

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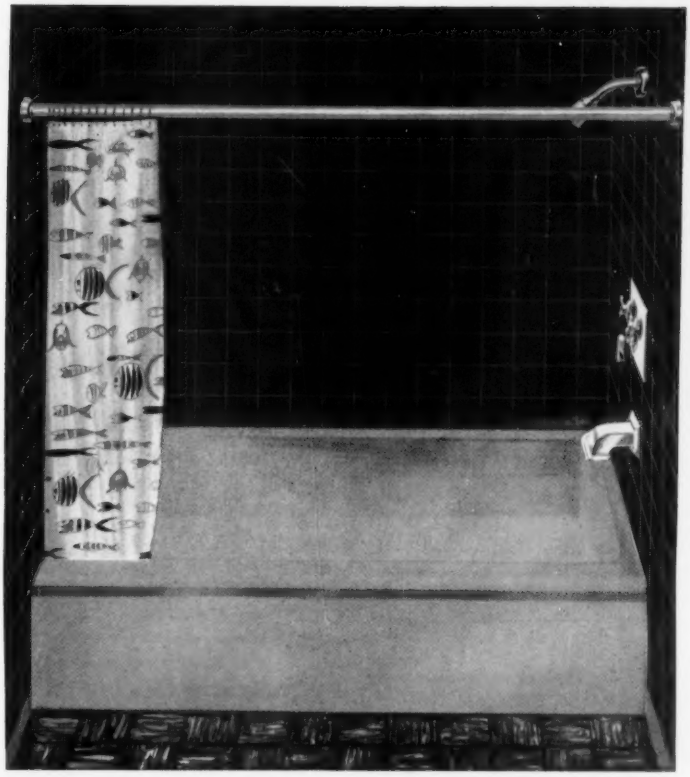

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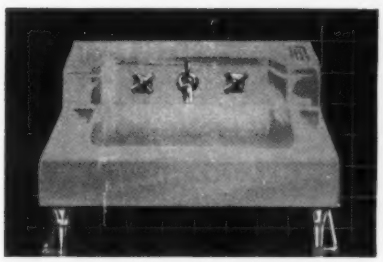

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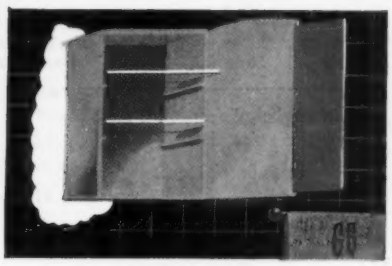

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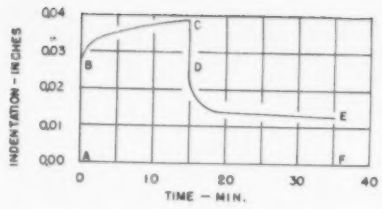

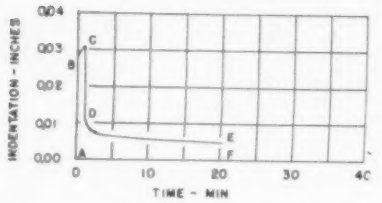

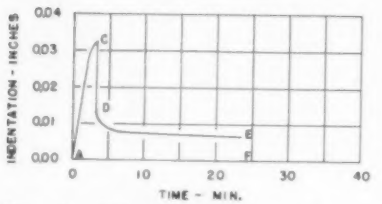

Fig. 3 (top)—Indentation-recovery curve, 15 min. under load
Fig. 4 (center)—Indentation-recovery curve, 1 min. under load
Fig. 5 (bottom)—Indentation-recovery curve, load gradually applied

place. If at this point the load is removed, an instantaneous elastic recovery, C-D, will take place followed by a delayed elastic recovery, D-E. The elastic recovery C-D is the result of the bond angles returning to their normal values and the delayed elastic recovery D-E is the result of the recovery of the retarded elastic element E_2 and η_2, recoiling of the chains into their natural configurations. The permanent set, E-F, corresponds to the flow of the dashpot η_3, chain-chain slipping.

If the length of time that the load is maintained is reduced, there is less time for the viscous elements to deform, as shown in Fig. 4 where the load was kept on for only 1 min. as compared with 15 min. in Fig. 3. Hence, when the load is removed after being applied for only a short time, we have more instantaneous elastic recovery, C-D, and less delayed elastic recovery, D-E, and less permanent set, E-F. From this it is apparent that the type and amount of recovery is dependent on the length of time the load is applied.

The recovery will also be affected by the speed at which the load is applied. Figure 5 shows the deformation and recovery when the load is gradually applied and then suddenly removed. We see that the instantaneous elastic recovery is about the same as in Fig. 4, but the permanent set is larger.

If hardness is measured by an indentation method such as the Rockwell M test, which measures the permanent indentation, we would expect that the results would depend on the rate of load application and the length of time that the load was applied. This being the case, and even though care is taken to time the loading rate and the time of load application in order to get reproducible results (3), the selection of the time cycle adds an arbitrary criterion to the test.

In rebound hardness tests, such as the Scleroscope (1), the rate of application of the load is determined by the height from which the indenter is dropped. If the height could be varied, the rate of load application would be different; hence, the response of the material would be affected.

We should expect some correlation between the hardness as measured by the Rockwell test of permanent deformation and the Scleroscope test of rebound, since the greater the permanent deformation the less the elastic recovery, hence the lower the rebound. Unfortunately this correlation is masked by the effect of rate of load application and the length of time of load application.

Hardness Values

For a comparative study of various hardness measurements the twelve polymeric materials shown in Table I were selected as representative of the various commercial types. Five metallic samples were also used for comparison.

The Rockwell M and the alpha Rockwell hardness values were taken in accordance with ASTM Method D 785-51 (3). The Rockwell M scale readings give a measure of the amount of deformation remaining after the major load of 100 kg. has been applied on a ¼-in. diameter indenter and removed in accordance with a time cycle allowing 15 sec. for load application and then 15 sec. for recovery. A minor load

Table I—Hardness Values of Various Plastics and Metals

Number	Material	Rockwell M hardness	Alpha Rockwell hardness	Scleroscope hardness
1	Alpha–cellulose–melamine plastic	123	114.5	101.0
2	Wood flour–phenolic plastic	116	119.5	78.0
3	Polymethyl methacrylate	102	110.5	98.5
4	Polystyrene	88	98.5	71.0
5	Nylon plastic	70	91.5	79.5
6	Rigid polyvinyl chloride	66	108.5	78.5
7	Ethyl celluiose plastic	—9	46.5	72.0
8	Polyethylene	—25	—151	44.5
9	Cellulose acetate butyrate plastic	—48	24.5	63.0
10	Plasticized polyvinyl chloride	Not applicable		13.5
11	Natural rubber	" "		46.0
12	Butyl rəbber	" "		10.0
13	Aluminum	" "		23.5
14	Brass	" "		14.5
15	Steel (mild)	" "		25.5
16	Steel	Rockwell C - 21.0		34.5
17	Steel	Rockwell C- 60.7		80.0

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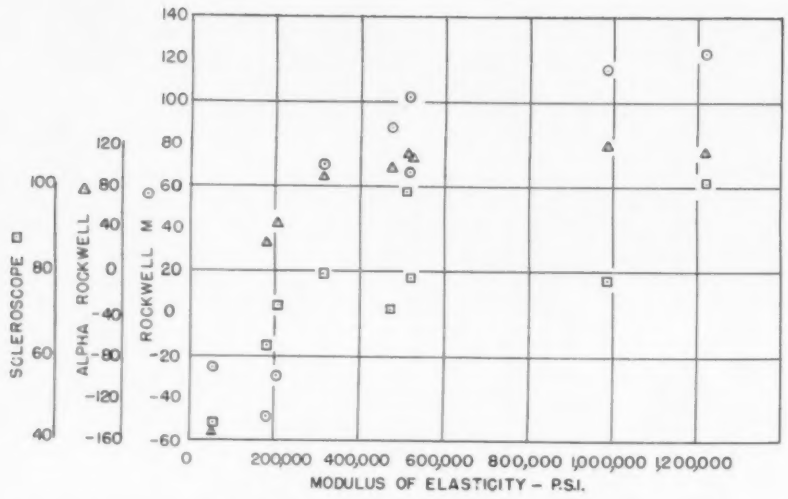


Fig. 6—Scleroscope, alpha Rockwell, and Rockwell M hardness values, compared to the modulus of elasticity of the plastics materials listed in Table I, page 128

of 10 kg. is maintained on the sample throughout the test. The alpha Rockwell readings give a measure of the total indentation resulting when a ½-in. diameter ball is pushed into the specimen with a major load of 60 kg. for 15 seconds. Again a minor load of 10 kg. is maintained on the specimen during the test. The readings are subtracted from 150 after being corrected for the spring constant of the machine.

The Rockwell M test is a measure of the so-called permanent indentation and the alpha Rockwell test is a measure of the total indentation, both permanent and elastic.

It is immediately apparent that the two tests do not rate the twelve materials in the same order. For example, the Rockwell M scale rates the melamine material as the hardest while the alpha Rockwell test rates the phenolic material at the top. The difference in relative ratings by the two test methods of rigid polyvinyl chloride and polyethylene is even more marked.

Since the Rockwell M test measures residual deformation and the alpha Rockwell test measures total deformation, it is not surprising that the two tests do not give the same relative ratings of hardness. A very rubbery material will have a high total indentation, but a small residual indentation after removal of load since it can recover rapidly. On the other hand, a material that does not recover readily may have either a large or small total deformation on the alpha Rockwell test.

The fourth column of Table I gives the Scleroscope readings for the polymeric materials and the metals. The values were obtained on a Shore Scleroscope using a diamond indenter. In this test the indenter falls on the surface of the specimen and the rebound is taken as a measure of the hardness. Good correlation of Scleroscope readings on metals with other hardness tests for metals has been demonstrated (1). The machine operates on the principle that the harder the material the less energy will be used in plastically deforming the specimen, hence the more will be available to cause the indenter to rebound.

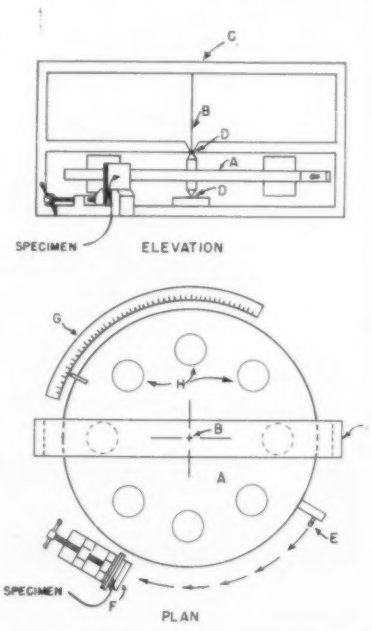


Fig. 7—Schematic diagram of torsion-spring rebound hardness tester

Looking at Table I we see that the Scleroscope readings rate the plastics in still a different order than either the Rockwell M or the alpha Rockwell; also that the Scleroscope readings on some of the plastics and rubbers indicate that they are harder than the metals including hardened steel. This situation has led to some criticism of the Scleroscope test by workers in the field of metals. It may possibly be true that melamine plastic is harder than steel, but one has difficulty in believing that nylon plastic is as hard as a 60 Rockwell C steel.

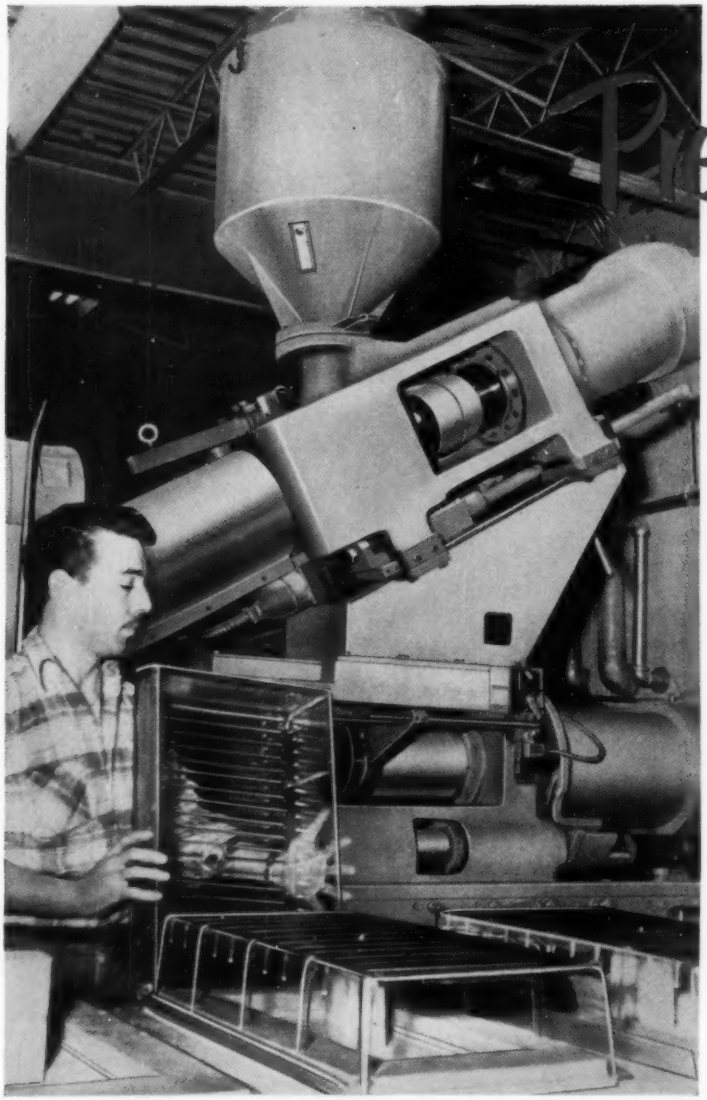
Modulus-Hardness Correlation

It has been stated that one of the properties of which hardness may be a function is the modulus of elasticity (4). In Fig. 6, the Rockwell M, alpha Rockwell, and Scleroscope hardness values are plotted against the modulus of elasticity of the plastics listed in Table I. We see that the Rockwell M values fall into three general groupings: the thermosets, melamine, and phenolic, with high modulus and high Rockwell M hardness; then a central group of nylon, polystyrene, polymethyl methacrylate, and rigid vinyl with fairly high Rockwell M readings and moderate moduli; and finally polyethylene and the two cellulose materials with low Rockwell M and low moduli. In general, there is a trend of higher Rockwell M readings with higher moduli.

The plot of alpha Rockwell hardness versus modulus of elasticity shows a smooth continuous curve. There is a marked increase of alpha hardness as the modulus goes up to half a millon, but above this value a two-fold increase in modulus does not appreciably increase the alpha Rockwell hardness.

The Scleroscope readings do not show any direct correlation with modulus other than the general trend upward with increasing modulus. They do not lie on a smooth curve.

The yield point, of course, is another important criterion of the resistance to indentation (4); if this



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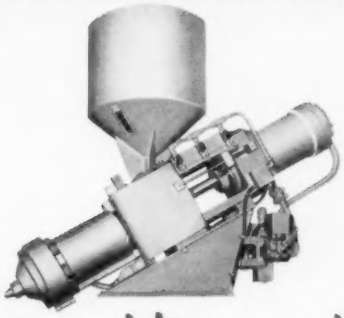

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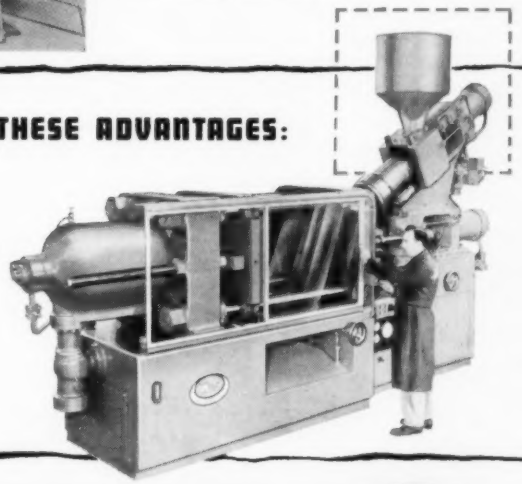

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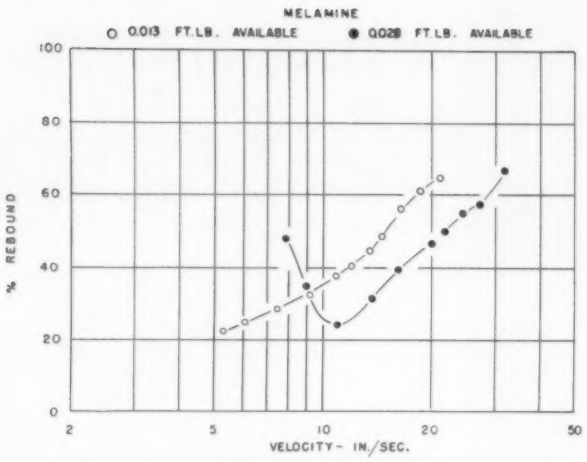


Fig. 8—Rebound hardness vs. velocity curves for melamine plastic

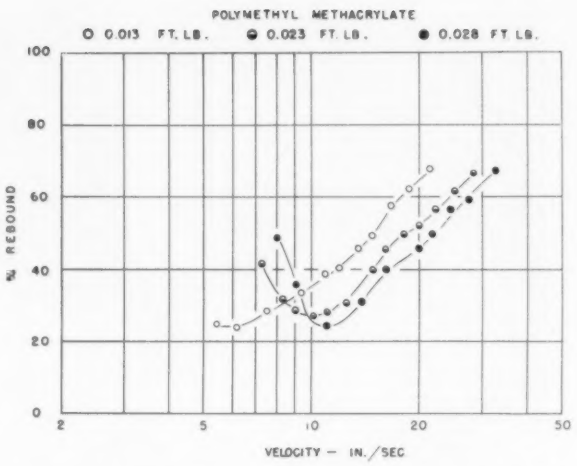


Fig. 9—Rebound hardness vs. velocity for polymethyl methacrylate

could be taken into consideration together with the modulus, some direct correlation with hardness measurements could be achieved if it were not for the fact that the yield point and the influence of the yield point is dependent on the loading rate. The influence of the yield point in indentation tests also, of course, depends on whether the force involved in the indentation is great enough to cause the material to reach the yield point associated with the rate of loading.

If we assume that the modulus of elasticity does not change radically with rate of loading, then it should be possible to run Scleroscope tests at various velocities by varying the height and weight and as long as the energy remained below some specific value the effect of yield point should not come in, i.e., the stress-strain curves would be the same.

In order to ascertain the effect of the rate of indentation on the hardness values of polymeric materials, two rebound-type testers were built. The principle of operation is based on the following. If a given driving force acting through a given distance is used to accelerate an indenter and then the rebound of the indenter is absorbed against the driving force, the distance that it works against the driving force will be a measure of the rebound hardness. In one machine the driving force is a torsional spring and in the other it is gravity.

Torsion-Spring Rebound Tester

Figure 7, p. 130, shows schematically the torsional spring machine. The rotor (A) is suspended by a fine steel wire (B) from the frame (C), and is free to rotate in the bearings (D). The indenter (E) is mounted on the periphery of the rotor in such a position that it will be just in contact with the specimen in the vise (F) when the torsion wire (B) is in its unwound position. In operation the rotor is turned back against the twist of the wire the desired number of degrees as indicated on the scale (G) and then allowed to swing free. The indenter hits the specimen, indents, and then rebounds. The rebound is read on the scale (G) and expressed as a percentage of the initial angle of release.

The energy of the blow can be controlled by controlling the initial angle of release. The velocity of the blow for any given angle depends on the moment of inertia of

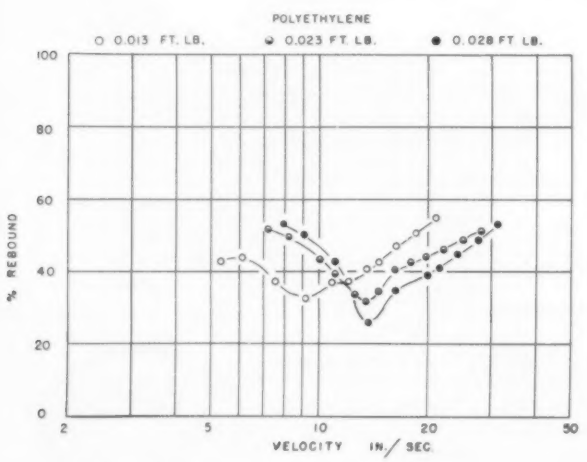


Fig. 10—Rebound hardness vs. velocity for polyethylene

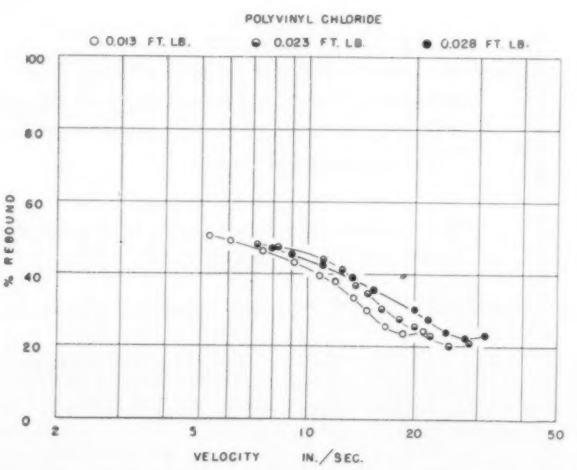
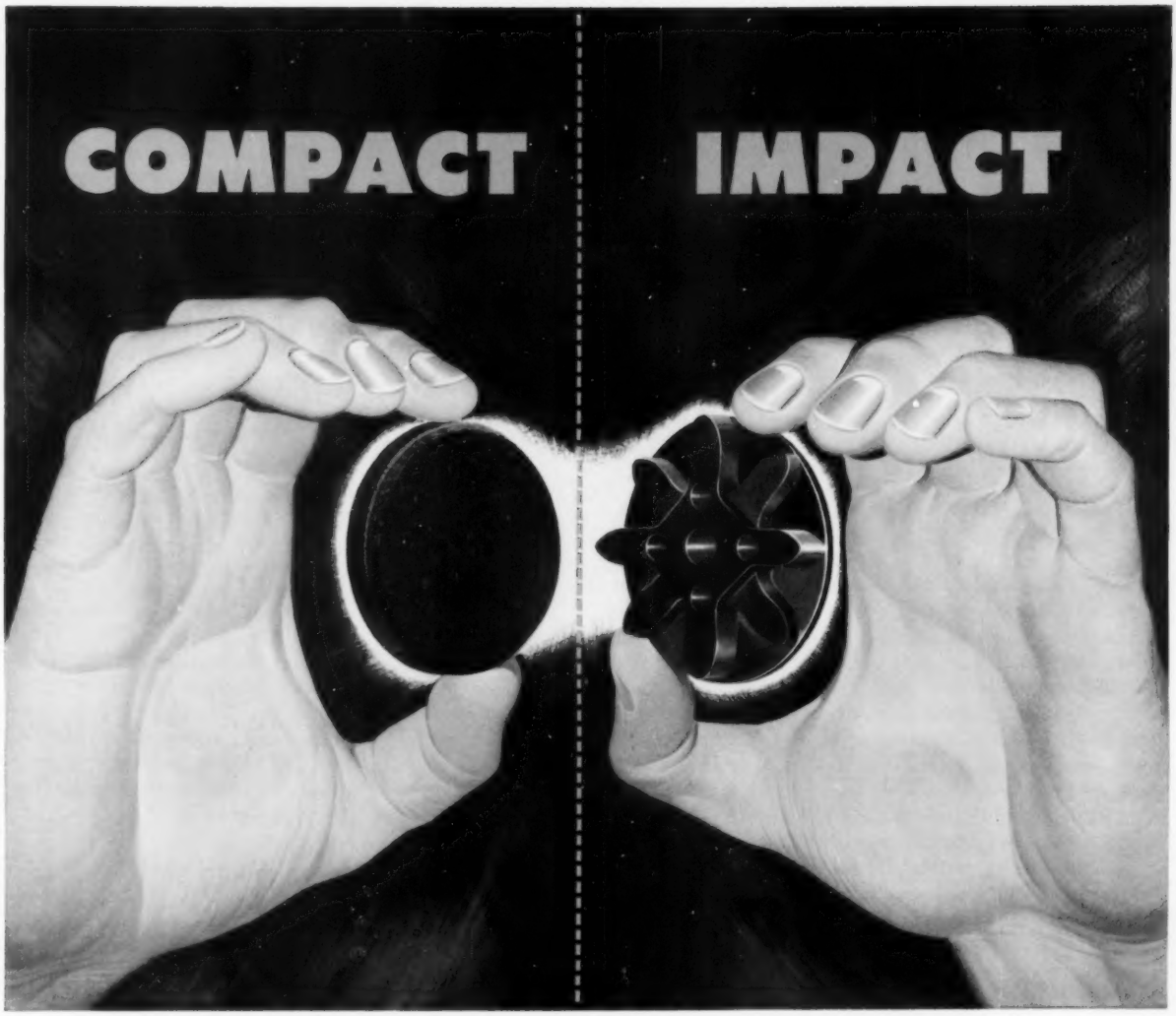


Fig. 11—Rebound hardness vs. velocity for polyvinyl chloride



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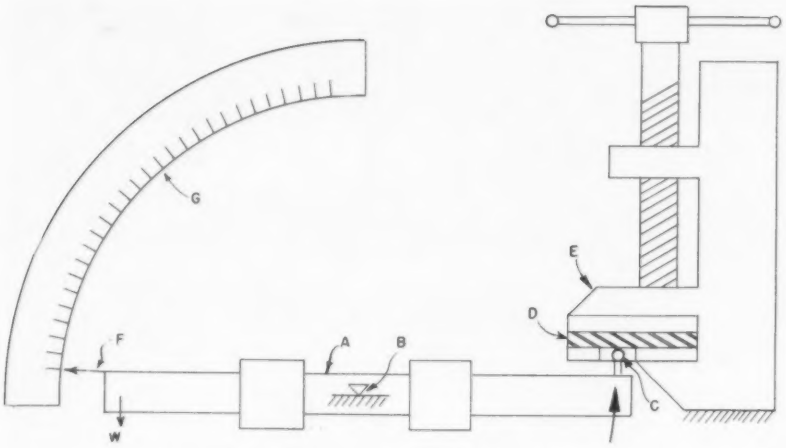

Fig. 12—Schematic diagram of low-energy rebound hardness tester

the rotor, which can be varied by adding or removing the weights (H). With this device it is possible to study the effect of changing the indenting velocity on the rebound hardness while, at the same time, holding the energy of the indentation constant.

Figures 8, 9, 10, and 11, p. 132, show results of such tests on melamine, polymethyl methacrylate, polyethylene, and plasticized polyvinyl chloride materials at room temperature. We can see that in each case the rebound hardness varies with the velocity of the indenter.

For the melamine, polymethyl methacrylate, and polyethylene materials at the higher energy levels of indenting, there is a general trend of first a decrease in the rebound percentage followed by a distinct increase as the velocity of indentation is increased. The change in rebound hardness in this velocity range may be greater than 100 percent. For the low energy level tests the decrease in rebound hardness for melamine and polymethyl methacrylate could not be picked up but only the direct trend of increasing percent rebound with increasing velocity of indenting.

In light of our general concept of the response of plastics to mechanical strain, it seems logical to expect an increase of percent rebound with increase in velocity, since as the velocity of straining increases the yield point increases and the amount of time for flow of bonds corresponding to η_2 and η_3 decreases. That is, the material exhibits a more elastic behavior as the rate of straining increases.

But this is not the whole story since we must consider the recovery of the material also. As shown in Figs. 3, 4, and 5, the recovery of a material is dependent on the rate of application of load and the length of time the load is left on. Therefore, we should expect the recovery to be more elastic if the velocity of indenting were increased, provided the energy remained constant.

It should be pointed out, however, that the method used for varying the velocity of the indenter, namely, increasing the moment of inertia in order to decrease the velocity, leads to the situation at low velocities where the sample after being strained is pushing against a large mass when it recovers. Hence, the indenter and the sample will be in contact for a longer time during recovery in the slow speed tests, thus permitting more recovery of the specimen while the two are in contact. This could lead to higher rebound measurements at low speeds, since the transfer of energy back to the indenter can only take place while the specimen and indenter are in contact. Thus it is possible to recover some energy from the delayed elastic recovery of the material at these velocities. This may be an explanation of the rise in the high energy curves of Figs. 8, 9, 10, and 11 at low velocities.

Plasticized polyvinyl chloride, as shown in Fig. 11, has very little instantaneous elastic recovery and a great deal of delayed elastic recovery. Hence, in light of the above, it seems logical that it should exhibit more of an increase in energy returned to the indenter as the velocity of indenting is decreased.

In light of the data shown in Figs. 8, 9, 10, and 11, let us consider what would happen if a one-point spot test were used to evaluate the hardness of a material. That is, suppose we evaluate the relative rebound hardness of these materials at only one specific velocity and energy of indentation, say minimum energy and 5.5 in./second.

The ratings of the materials would be:

Plasticized polyvinyl chloride	50%
Polyethylene	43%
Polymethyl methacrylate	25%
Melamine plastic	22%

This is directly opposite to the relative ratings shown in Table I for hardness measurements by the Rockwell method and the Shore Scleroscope. If we picked another velocity and energy from Figs. 8, 9, 10, and 11, say maximum energy and 31 in./sec., the ratings of the materials would be

Melamine plastic	67%
Polymethyl methacrylate	67%
Polyethylene	53%
Plasticized polyvinyl chloride	23%

This is opposite to the above ratings and somewhat in line with the ratings of Table I. We must conclude that the whole spectrum of velocities and energies must be measured if we are to truly evaluate the response of these materials to indentation because of their sensitivity to the rate of loading and the amount of indentation.

Low-Energy Rebound Tester

The second variable speed rebound tester is shown schematically in Fig. 12. A balanced beam (A) is supported on the knife edge (B). At one end is the indenter (C) and at the other end weights may be added (W) to supply the driving force. The specimen (D) is clamped in the rigidly supported vise (E). The pointer (F) and scale (G) are used to measure the initial starting angle and the rebound angle. With this device very slow velocity rebound hardness tests may be made at very low energy levels by using a very small driving force (W);

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the entire apparatus was placed in an oven to investigate the rebound hardness at various temperatures.

Figure 13, below, shows the results of tests at 0.001 in.-lb. energy and 2.6 in./sec. velocity over the temperature range of 25 to 110° C. As might be expected, the testing temperature has a marked effect on the rebound hardness. As the temperature is increased the viscosity corresponding to η_2 will decrease, allowing the material to have a larger and more rapid delayed elastic response. But at the same time the viscosity corresponding to η_3 will also decrease, permitting a greater permanent set. Therefore, the effect of increasing temperature cannot be predicted since it depends on the interrelation of the changes in these two quantities and the values of E_1 and E_2; or, speaking in terms of the molecular structure, an increase in temperature will allow a more rapid chain uncoiling and recoiling, but at the same time more chain-chain slipping can take place.

Looking at Fig. 13 we see that for a tightly cross-linked material such as melamine plastic, temperature has little effect on its rebound characteristics. For rigid polyvinyl chloride, increasing the temperature first increases the percent rebound and then there is a marked decrease; that is, at high temperature this material does not respond elastically. On the other hand, the highly plasticized polyvinyl chloride shows a very marked increase in percent rebound at high temperatures, indicating that as the temperature increases the time constants involved in recovery are greatly reduced. The curve for polystyrene shows a marked change in the neighborhood of the second order transition.

The same observation made earlier about the effect of changing the velocity on the rebound characteristics can be made here about the effect of change of temperature. The relative ratings of these materials at 25° C. is very different from the relative ratings at 80 or 90° C.; that is, testing at one temperature will not give a comprehensive picture of the hardness of a material.

Conclusions

From the data given it is apparent that the results of indentation hardness tests are dependent on time and temperature. These two factors must be studied as controlled variables if we are to have a true understanding of the hardness behavior exhibited by polymeric materials.

In general, we may conclude that hardness testing and the results of hardness tests must be evaluated in light of the application in which we intend to use the plastic material under consideration. That is, the design engineer interested in the relative rating of various materials for some specific application must use a test that corresponds to the type of loading to be encountered in the application. He should consider such questions as whether the loading will be rapid or slow, and test at the use-time scale; whether the loading will be one where the total indentation will be the determining criterion, and test by that method; whether the loading will be indentation followed by rebound where the energy absorbed or percent rebound will be the important factor; and, finally, whether the application for which the polymeric material is to be used will be at the test temperature.

One should bear in mind that the ability to absorb energy of indentation and to return it to the indenter, such as in rebound hardness tests, is often more important than just the ability to resist indentation, as in the alpha Rockwell test. In cases where abrasion resistance or mar resistance are to be inferred from hardness tests, the ability to recover elastically from the indentation is an important criterion. Hence, a material such as a metal may have high resistance to total indentation but if plastic flow takes place it will suffer deformation from the energy it absorbs, while on the other hand some polymeric materials will recover rapidly and completely from the indentation and not absorb the energy. Therefore, it seems reasonable that in the Scleroscope test some plastics have ratings that are actually higher than those for hardened steel.

As for the definition of hardness it seems best in light of the above to say that so far as plastics are concerned hardness is the resistance to indentation, but the type of resistance and the type of indentation depends upon the application to which we wish to place our data, and the time and temperature scale involved.

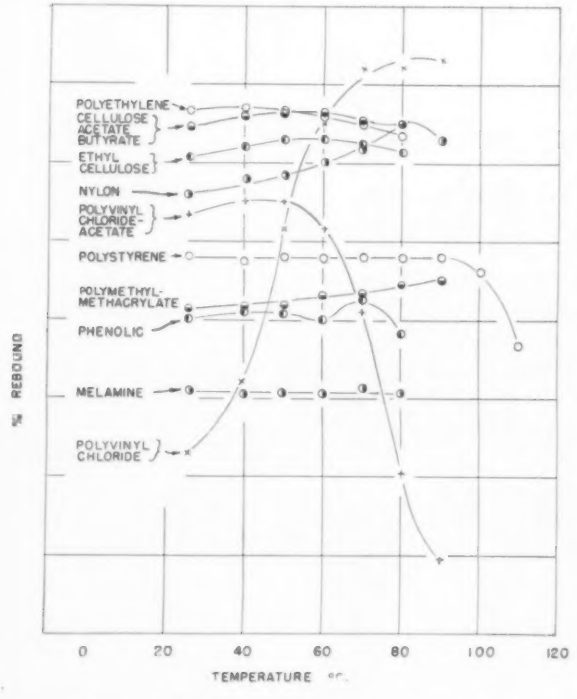

Fig. 13—Rebound hardness vs. temperature curves for a variety of polymeric materials

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Effects of Temperature and Degree of Polymerization on

SORPTION OF WATER by Polymethyl Methacrylate*

The sorption of water by a series of methyl methacrylate polymers has been studied as a function of temperature and degree of polymerization. Sorption is nearly independent of temperature from 0 to 60° C. Thin specimens reach a steady state value within a short time. In the vicinity of the glass temperature, T_g, the sorption of water increases rapidly. The polymers show large weight increases on exposure to water above T_g and steady state sorption values are not obtained.

Sorption is markedly affected by the molecular weight of the polymer above T_g. Specimens of larger molecular weight show smaller weight increases. Sorption of water by the polymers is reversible. Degradation takes place during molding at 150° C. and limited hydrolysis occurs on exposure to boiling water; both treatments lead to increased sorption of water. The increase in sorption of water above T_g is thought to be due to the less rigid linkage in the polymer chains and an expansion of the structure which allows water to permeate more readily into the material.

by G. M. BRAUER† and W. T. SWEENEY†

POLYMERS in contact with water or water vapor will remain greater or smaller amounts of water depending on the number of polar groups in the polymer (1, 2, 3, and others).[1] The time necessary to reach steady-state conditions depends on the thickness and water permeability of the material. For many polymeric materials, the steady state is reached only after prolonged exposure. At the surface, however, equilibrium conditions may be reached within a relatively short time.

Recently, a number of investigators have dealt with the kinetics of vapor sorption by polymer films. Kokes, Long, and Hoard (4) and Long, Bagley, and Wilkins (5) reported a pronounced change in the character of the diffusion that takes place in the region of the glass temperature[2] of the polymer-penetrant mixture. With both the polar acetone-polyvinyl acetate and the non-polar benzene-polystyrene systems, diffusion was found to obey Fick's law only when the system was above the glass temperature. A similar behavior was observed for the diffusion of gases through polyvinyl acetate (6).

Richards (7) showed that high-molecular-weight polyethylenes are less soluble and absorb less organic liquid than low-molecular-weight polyethylenes. Specimens of the same molecular weight that contain a higher portion of short chain material are more soluble and swell more in organic liquids.

The effects of temperature and molecular weight on the sorption of water by polymethyl methacrylate were studied in the present investigation. Sorption of water as used in this paper refers to the approximately uniform penetration of water into the polymer as well as the uptake of water caused by capillary action and is assumed to be equal to the weight changes observed.

Experimental Procedures

Sorption of Water by Molded Specimens — Polymethyl methacrylate powder was placed in a mold cavity 5 cm. in diameter and 0.05 ± 0.01 cm. in thickness. The material was molded into disks in a Carver laboratory press at 10,000 p.s.i. and 150 ± 5°C. for 1 hour. The specimens were dried at 70°C. to constant weight (±0.2 mg.), placed in holders, and kept in water at the desired temperature. At various time intervals the disks were transferred to another water bath kept at room temperature. After 10 min., the specimens were dried by rubbing with a clean towel for 20 sec., dried in air by waving for 20 sec., and weighed within 20 seconds. The disks were then placed back in the original water bath. This process was repeated until constant weight (±0.2 mg.) was obtained. To determine any loss in weight that may have been caused by solubility of the polymer in water, the disks after reaching constant weight were dried in an air oven at 70°C. or over 96% sulfuric acid at room temperature. Duplicate specimens were used for all determinations.

Sorption of Water by Sheet Specimens — Samples of polymethyl methacrylate of approximately 0.63-cm. thickness, which had been polymerized in sheet form using a mercaptan as chain terminating agent to control molecular weight, were obtained from the Rohm and Haas Co.[3] Table I, p. 140, shows the values for viscosity molecular weight as reported by the manufacturer, approximate number average molecular weight determined by the method of Caul and Schoonover (8), Knoop hardness, and glass temperature.

The specimens were dried to constant weight (±0.2 mg.) and placed in boiling water. After various time intervals, the specimens were weighed by the procedure described above. Water desorption measurements were made in dupli-

* Paper presented at the 126th Meeting of the American Chemical Society, New York, 1954.
† Dental Research Section, National Bureau of Standards.
[1] Numbers in parentheses link to references at end of article, p. 220.
[2] Glass temperature is the temperature at which a change in slope takes place when any one of the primary thermodynamic properties of a material is plotted against temperature.

[3] The authors wish to thank W. F. Bartoe of the Rohm and Haas Co. for supplying the samples.

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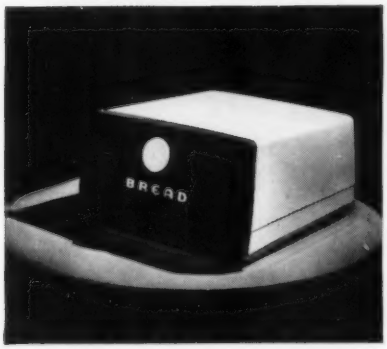

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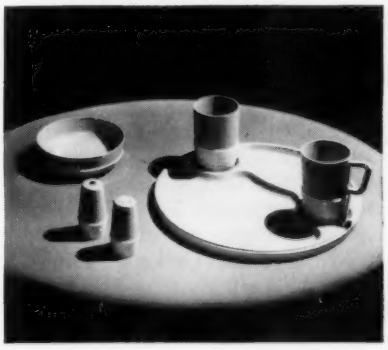

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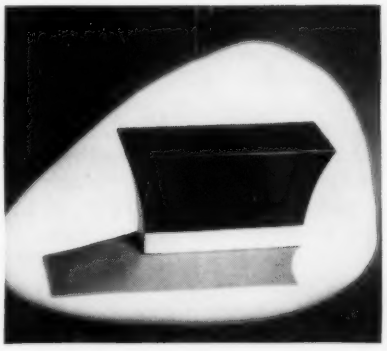

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Table I—Properties of Polymethyl Methacrylate Sheet Samples

Sample No.	Viscosity average molecular weight[a,b]	Number average molecular weight[c]	Knoop hardness	Glass Temp. (T_g)[d], °C.
1	45,000	2000	17.7	79
2	64,000	2900	18.6	86
3	123,000	3500	20.4	91
4A	393,000	4500	21.3	100
5A	1,615,000	5500	21.8	103

[a] The molecular weight determinations were made by W. F. Bartoe and S. S. Steck of the Rohm and Haas Co. using the formula:

$$M = K\,[\eta]^{\alpha}$$

where M = molecular weight, K = a constant = 3.34×10^5, $[\eta]$ = intrinsic viscosity computed from data expressed in g./100 ml. concentration, and α = a constant = 1.32. All of these viscosity determinations were made in ethylene dichloride at 25° C. and a concentration of 2 g./liter.

[b] After storing in boiling water for 108 days, drying, and storing in water at 37° C. for 750 days, specimens of molecular weight 45,000 to 123,000 showed no change in viscosity average molecular weight; the specimens of original molecular weight 393,000 and 1,615,000 showed a decrease in molecular weight to 320,000 and 800,000, respectively.

[c] Determined by the method of Caul and Schoonover (8).

[d] The heat distortion temperature as reported by the manufacturer was approximately 90° C. for the lowest molecular weight material and varied from 95 to 100° C. for the others. T_g of pure dry polymethyl methacrylate in the 40,000 to 1,600,000 molecular weight range is constant at 105° C. (19). Any variations in glass temperature are likely to be caused by variations in residual monomer content.

cate by placing the specimens over anhydrous calcium sulfate (Drierite) in a desiccator first at 21°C. for 241 days and finally at 70°C. for 1 day. Another series of measurements of specimens of the same thickness was made at 37°C.

Effect of Molding on Sorption of Water — Specimens measuring 6.0 by 6.0 by 0.7 cm. were prepared by heating a 1:3 part monomer-polymer mixture (by volume) at 71°C. for 1.5 hr. and then at 100°C. for 0.5 hour. To avoid any temperature rise, several of these specimens were cut under water into strips 0.05 cm. thick, 6.0 cm. long, and 0.7 cm. wide. Another series of these specimens was reduced to the same thickness as the cut specimens by molding at 100°C. and 10,000 p.s.i. pressure for approximately 0.5 hr. in a Carver laboratory press.

Water Vapor Sorption Measurements — Attempts to measure water vapor sorption with the McBain balance did not prove satisfactory. Since the sorption of water by polymethyl methacrylate at 30°C. is comparatively small (maximum sorption less than 2%), a large specimen was required. The equipment available was not sufficiently sensitive to detect the small changes in weight caused by sorption of water vapor by these specimens.

The weighing bottle and salt solution method reported in detail by Mellon, Korn, and Hoover (9) was adopted. Specimens weighing approximately 4 g. were placed in weighing bottles (diameter, 7 cm.; height, 3 cm.) and dried to constant weight (±2 mg.) at 70°C. and a pressure of less than 5 mm. of mercury. Weighing bottles and contents were placed in desiccators over the proper salt solutions. The desiccators were evacuated to a pressure of 50 mm. of mercury for a few minutes and placed in an air bath kept at 30.0 ±0.3°C. Weighing bottles were weighed after a few days using the precautions given by Mellon et al. (9). Weighings at each humidity were repeated until the change in weight was less than ±2 milligrams. The specimens were kept a minimum of 10 days at each humidity. Specimens were started at the lowest (11.8%) and highest (93.3%) relative humidities and on reaching equilibrium were moved to the next higher or lower humidity, respectively. This was continued until the maximum (or minimum) humidity had been reached. After completion of the last sorption measurement, the specimens were dried again by the procedure described above to check the original weight. An empty weighing bottle was used as tare for all weighings. This bottle, accompanied the bottles containing the specimens through all manipulations. Water vapor sorption measurements by this procedure are considered to be precise within 0.05 percent.

Hydrolysis of Polymethyl Methacrylate in Boiling Water — A 100-g. specimen of polymethyl methacrylate (Du Pont HG1 powder) and 300 ml. water were placed in a 500-ml. round bottom flask. The flask was connected through a ground glass joint to a 35-cm. drip-tip Friedrichs condenser. To avoid loss of volatile constituents, the condenser was connected to a mercury seal. The water was heated to boiling. Continuous agitation was accomplished by means of a magnetic stirrer. At various time intervals, 1-ml. portions of the supernatant liquid were removed for analysis. Methanol content was determined by mass spectrometry. The minimum concentration that can be detected by this procedure is less than 0.02 mole percent. The pH of the solution was determined with a Beckman pH meter.

Determination of Glass Temperature (T_g) — Glass temperature (T_g) was determined refractometrically (10, 11) using a Zeiss-Abbé refractometer. Specimens of the molded material were placed directly between the prisms. Strips were cut from the polymethyl methacrylate sheet under water and then placed in the refractometer. Films from the polymer powders were cast from acetone solutions on the lower prism of the refractometer. The films were carefully dried at room temperature for at least 24 hr. and at 110°C. for 0.5 hour. Refractive index measurements were made by slowly heating the refractometer to 110°C., a temperature well above T_g, and lowering the temperature to obtain subsequent readings. Emphasis was placed on relative and not absolute accuracy of the n_D readings. T_g values were determined with a precision of better than ±2°C. by locating the intersection of the linear portions of the temperature versus n_D plot.

Molecular Weight Determinations — Viscosity average molecular weights[4] were determined by measuring the intrinsic viscosity $[\eta]$ of chloroform solutions of the polymers at 25°C. in a calibrated Ostwald-Fenske viscometer. Molecular weight was calculated using the relationship (12):

$$[\eta] = 2.52 \times 10^{-3}\,M_V^{0.80}$$

Viscosity average molecular

[4] $M_V = [\Sigma\, W_i\, M_i^{\alpha}]^{1/\alpha}$ where W_i = weight fraction of molecules of weight M_i and α = a constant.

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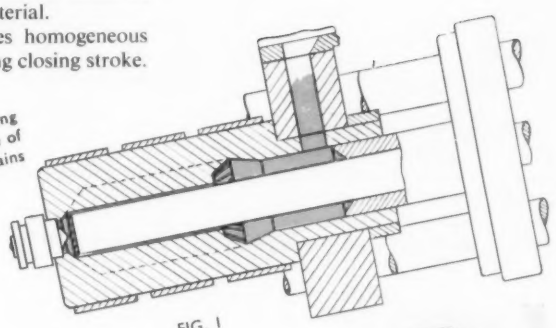

FIG. 1

Fig. 1.—FORWARD POSITION. Here the prefilling ring has drawn back clear of the feed and a fresh charge of material passes into the cylinder; the plunger remains forward.

Fig. 2.—BACK POSITION. After the new charge has been drawn in, the prefilling ring travels forward, compressing the material at the same time as the plunger moves back ready for its forward injection stroke. The nozzle is designed to restrict the escape of material during this action.

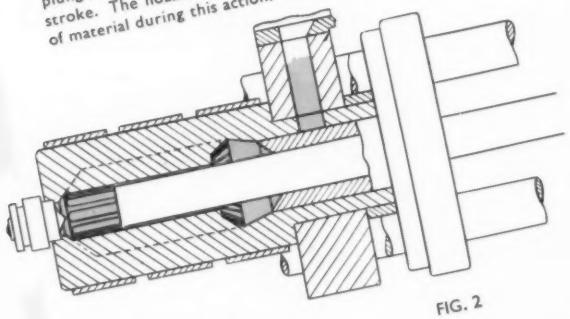

FIG. 2

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Area of Injection plunger	2.074 sq. in.
Pressure per square inch on material at end of plunger	9,100 lb.
Total pressure on Injection plunger	18,850 lb.
Mold opens (adjustable)	6—9 in.
Maximum die space	7¼ in.
Minimum die space	3½ in.
Maximum recommended casting area in mold	15 sq. in.
Size of die plates	16 x 10 in.

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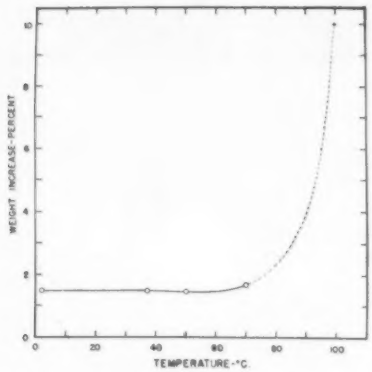

Fig. 1—Effect of temperature on sorption of water by polymethyl methacrylate disks, 0.05 cm. thick, molded from Du Pont HG4 fine dental material. (Water sorption value at 100° C. does not represent an equilibrium value)

weights in ethylene dichloride reported in Table I for the polymer sheets are those given by the manufacturer.

Approximate number average molecular weights were determined by the method of Caul and Schoonover (8). All determinations were made in duplicate.

Temperature Versus Water Sorption

The effect of temperature on the sorption of water by molded polymethyl methacrylate disks (Du Pont HG4 fine) is shown in Fig. 1. In the 2 to 60°C. range, it is constant and independent of the temperature. The samples reach constant weights within 30 days. It has been reported (13) that no further change in weight takes place even after storage for an additional 5 years. At 70°C., in the neighborhood of T_g, water sorption starts to increase. Two specimens stored at 100°C. (Table II) continued to gain weight after immersion in water for about 200 days. During this period, the increase in weight reached approximately 10% (Fig. 1). This is nearly seven times as large as the steady state water sorption value at 37°C. (1.48%). The difference in sorption of water by the two specimens stored at 100°C. may be caused by variations in molding conditions.

Polymer disks kept in boiling water become cloudy. This indicates that a marked internal inhomogeneity is present, giving rise to refractive index gradients. It has been pointed out by McLaren and coworkers (14-15) that presumably water is localized as submicroscopic droplets in the neighborhood of the polar groups in polymers.

On redrying to constant weight, disks immersed at 2 and 37°C. show an insignificant decrease from the original weight (less than 0.1%); those stored at 50 and 70°C. decrease in weight by less than 0.25 percent. Specimens stored at 100°C. have a 2.5% loss in weight. This is probably caused by the increased solubility of low molecular weight products and plasticizers which leach out to a greater extent at the elevated temperatures.

Effect of Molding

As can be seen from Fig. 2, specimens cast from dental monomer-polymer mixture and subjected to simulated molding conditions have a greatly increased sorption of water compared to specimens cut from the cast material. Apparently degradation takes place during the molding process. The larger concentration of monomer and polar low-molecular-weight material in the molded specimen may cause the increased water uptake. Further evidence of the formation of water-soluble compounds during molding is the increased weight loss on drying.

Hydrolysis and Depolymerization

The formation of polar hydrolysis products such as methacrylic acid, even in small concentrations, will greatly increase sorption of water because of increased chemical interaction at the hydrophilic sites. Hydrolysis of polymer in boiling water was, therefore, investigated. Mass spectrometer analysis showed the absence of methanol in water samples removed from water-polymer powder mixtures after stirring for 3 days at room temperature. When the polymer was kept for 4 days at 100°C., 0.4% yield of methanol (based on the theoretical yield of methanol formed from polymer) was obtained. The water solution was acidic (pH 3) and gave a positive Bayer test for unsaturation. Prolonged (30 days) exposure to boiling water did not give an appreciable increase in the concentration of the hydrolysis products formed. Mass spectrometer analysis of the final fraction obtained on distillation of the aqueous solution of the hydrolysis products indicated the presence of methacrylic and possibly pyruvic acid, the latter suggesting formation of an unstable hydroperoxide as an intermediate in the degradation mechanism.

Effect of Molecular Weight

Sorption of water at 100°C. is shown in Fig. 3, p. 147. Sheet specimens, 0.63 cm. in thickness, are of different molecular weights. The properties of these samples are

(*To page* 147)

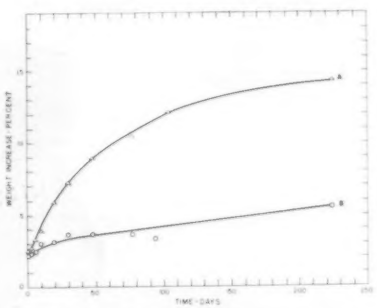

Fig. 2—Effect of molding on sorption of water by polymethyl methacrylate. Thickness of specimens: 0.05 cm.; temperature: 100° C. A—Specimens reduced in thickness under simulated molding conditions at 150° C. and 10,000 p.s.i. B—Specimens of as-cast material

Table II—Water Sorption by Polymethyl Methacrylate

(Material: HG4 Fine; Temperature: 100°C.; Thickness of disks: 0.05 cm.)

Specimen 1		*Specimen 2*	
Time in water	*Weight increase*	*Time in water*	*Weight increase*
days	*%*	*days*	*%*
3	3.0	4	3.0
27	5.6	32	6.9
73	6.4	61	8.5
102	7.2	99	9.2
213	9.0	172	11.7

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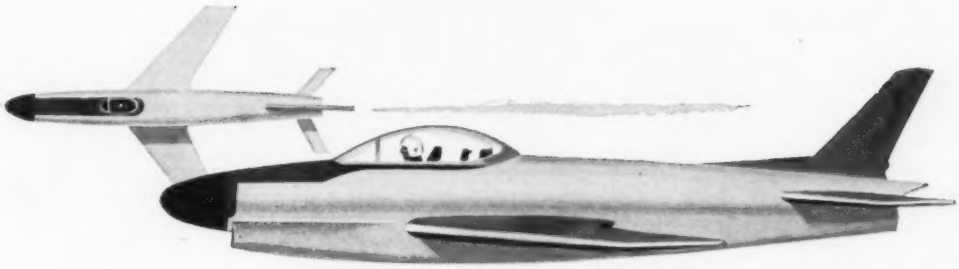

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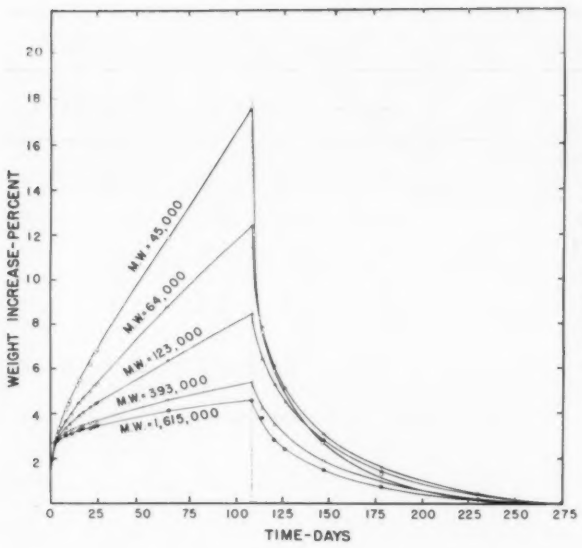

Fig. 3—Effect of molecular weight on sorption and desorption of water by polymethyl methacrylate cast specimens, 0.63 cm. thick. Desiccant: anhydrous calcium sulfate. Sorption at 100° C., desorption at 21° C.

shown in Table I. Lowering of the molecular weight of the polymer results in increased water sorption. The sorption curves are made up of two distinct parts. After a rapid rise, the curves become nearly linear. The logarithmic plot of water sorption versus time gives a nearly linear curve only for the sample of viscosity molecular weight 1,615,000 (Fig. 4). The difference in behavior may be due to the fact that the glass temperature of this material was slightly above 100°C., whereas T_g of the other materials was 100°C. or less.

Sorption values are most sensitive to variations in the molecular weight of the polymer in the low molecular-weight range. Differences in weight-gain of specimens of viscosity molecular weight 393,000 and 1,615,000 are small. Sorption does not appear to be significantly altered by changes in molecular weight above a limiting value which is in the neighborhood of 500,000.

Placed over anhydrous calcium sulfate, the specimens lose water (Fig. 3). Differences between the original weight and the weight after complete removal of water is a measure of soluble constituents. These differences are small and, after drying for 242 days, amount to a minimum of 0.13% and a maximum of 0.35% for the 1,615,000 and 45,000 molecular weight materials, respectively.

These same specimens were then stored in water at 37°C. They did not reach steady state conditions. After 750 days' exposure, the lowest - molecular - weight sample showed a gain in weight of 13.7% as compared with 4.7% for material of the highest degree of polymerization (Fig. 5). Plotting the logarithms of time and water sorption gives a straight line only for the sample of lowest molecular weight.

For the specimens up to 123,000 molecular weight, no depolymerization was observed on storing in boiling water for 110 days, drying for 241 days at 21°C. and 1 day at 70°C., and storing in water at 37°C. for 750 days. The specimens of highest molecular weight, when treated in the same manner, showed a decrease in molecular weight from 1,615,000 to 800,000 (see note *b*, Table I). Depolymerization may take place during the drying period at 70°C. or on storage in water.

The rate of sorption of water at 37°C. by freshly prepared specimens of 0.63-cm. thickness is much slower when compared with similar specimens which had previously been immersed in boiling water and dried. Steady state conditions apparently are reached within 3 months. The sorption amounts to approximately 1.9 percent. The sorption values are not affected by thickness of the specimens or molecular weight. Similar results have been obtained by Rose and coworkers (16) for polymers containing insoluble fillers and cross linking agents.

Failure to reach steady state conditions, dependence on molecular weight, and the increased rate of sorption of water at 37°C. by specimens previously stored in boiling water may be caused by voids. Swelling in boiling water may not be completely reversible. On drying, the water diffuses to the surface and evaporates. Holes or discontinuities may remain at the original water sites. On placing such a specimen in water at 37°C., the sorption process will depend mainly on capillary flow. The water progresses as a separate phase through more or less discrete pores of the resin (17). Sorption becomes abnormally large and no definite saturation limit is reached on prolonged exposure.

Water sorption measurements, in the 4 to 70°C. range, of disks (thickness 0.05 cm.) molded of fractionated polymer, are reported in Table III, p. 148. Substantial lowering of viscosity molecular weight indicates that degradation takes place during molding. Constant sorption values are obtained in all determi-

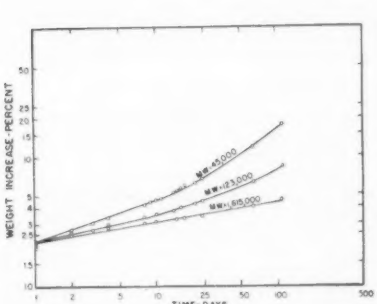

Fig. 4—Log-log plot of time versus sorption of water at 100° C. by polymethyl methacrylates of various molecular weights. Thickness of specimens: 0.63 centimeter

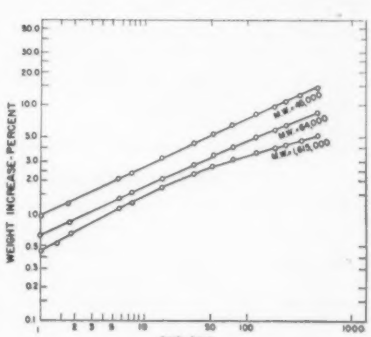

Fig. 5—Log-log plot of time versus sorption of water by polymethyl methacrylates of various molecular weights at 37° C. (Specimens had been previously heated in boiling water for 108 days and then dried)

Table III—Effects of Molecular Weight and Temperature on the Sorption of Water by Polymethyl Methacrylate[a]

Molecular weight		Glass temperature, °C.		Equilibrium water sorption in percent at temperatures shown				
Original specimens	Molded specimens	Original specimens	Molded specimens	4°C.	30°C.	37°C.	60°C.	70°C.
195,000	180,000	77	93	2.07	1.94	2.00	2.18	2.80
195,000	187,000	77	75	2.05	1.98	2.01	2.22	2.61
600,000	380,000	62	55	2.04	1.94	1.99	2.12	2.77
600,000	398,000	62	59	2.07	1.94	2.00	2.18	2.80
1,560,000	824,000	68	68	2.05	1.97	1.97	2.11	2.35
1,560,000	—	—	—	2.06	1.95	1.92	2.05	2.26

[a] Original fractionated polymer was obtained from H. D. Justi and Sons, Inc. Thickness of molded disks was 0.05 cm.

nations. Sorption is independent of molecular weight in the 4 to 37°C. range. Between 60 and 70°C., in the vicinity of the glass temperature, sorption values rise with a smaller increase at higher molecular weights. The small difference between the water sorption values of the specimens of approximately 180,000 molecular weight and those of approximately 390,000 molecular weight may be caused by the abnormally high glass temperature of the lowest molecular weight specimens. In the absence of detailed data on polymerization methods and history of these samples, it is difficult to clarify this discrepancy. On raising the water temperature above 70°C., the highest-molecular-weight (1,560,000) specimens decompose into granules similar to those from which they were molded (Fig. 6).

Effect of Relative Humidity

Results of the studies of the sorption of water vapor by methyl methacrylate polymer at various relative humidities at 30°C. are given in Table IV. For most samples, water uptake is nearly linear from 10 to 50% relative humidity. In this range, water probably dissolves in the resin; the quantity dissolved is proportional to the relative humidity in accordance with Henry's law. Above 80% relative humidity there is generally a more rapid increase in the amount of water sorbed. This upswing may reflect adsorption in multilayers or capillary condensation. Within experimental error, water vapor sorption appears to be independent of the molecular weights of the polymers. The equilibrium values for desorption are slightly higher than the corresponding sorption values in the 10 to 50% relative humidity range. From the limited data available, it is not possible to state whether exposure to vapor at 100% relative humidity and immersion in water give identical results. Investigations by Kovacs (18) show that the water immersion procedure gives about 3% higher values for the increase in weight.

Fig. 6—Effect of immersion in hot water on disks molded from fractionated polymethyl methacrylate of molecular weight 1,560,000. Light-colored mass in foreground is disk after storage in water above 70° C. Freshly molded disk is shown in background

Water Sorption Versus T_g

The rapid rise of the water sorption in the neighborhood of T_g of the specimens immersed in water may be explained by an increase in the mobility of the polymer segments. Above T_g, the chains have a greater degree of freedom. The

(To page 220)

Table IV—Sorption of Water Vapor by Polymethyl Methacrylate at 30.0 ± 0.3° C.

Saturated salt solution	Relative humidity, %	Equilibrium weight increase, %					
		HG4 Fine		Fractionated Polymer			
				M.W. = 195,000		M.W. = 1,560,000	
		Sorption	Desorption	Sorption	Desorption	Sorption	Desorption
LiCl	11.8	0.04	0.11	0.09	0.12	0.06	0.12
$MgCl_2$	31.4	0.27	0.35	0.35	0.42	0.32	0.44
$Mg(NO_3)_2$	50.9	0.57	0.64	0.53	0.74	0.54	0.70
NaCl	75.1	1.04	0.97	1.13	1.04	1.16	1.04
KCl	83.6	1.18	1.13	1.32	1.31	1.35	1.29
KNO_3	93.3	1.33	1.49	1.83	1.56	1.67	1.62

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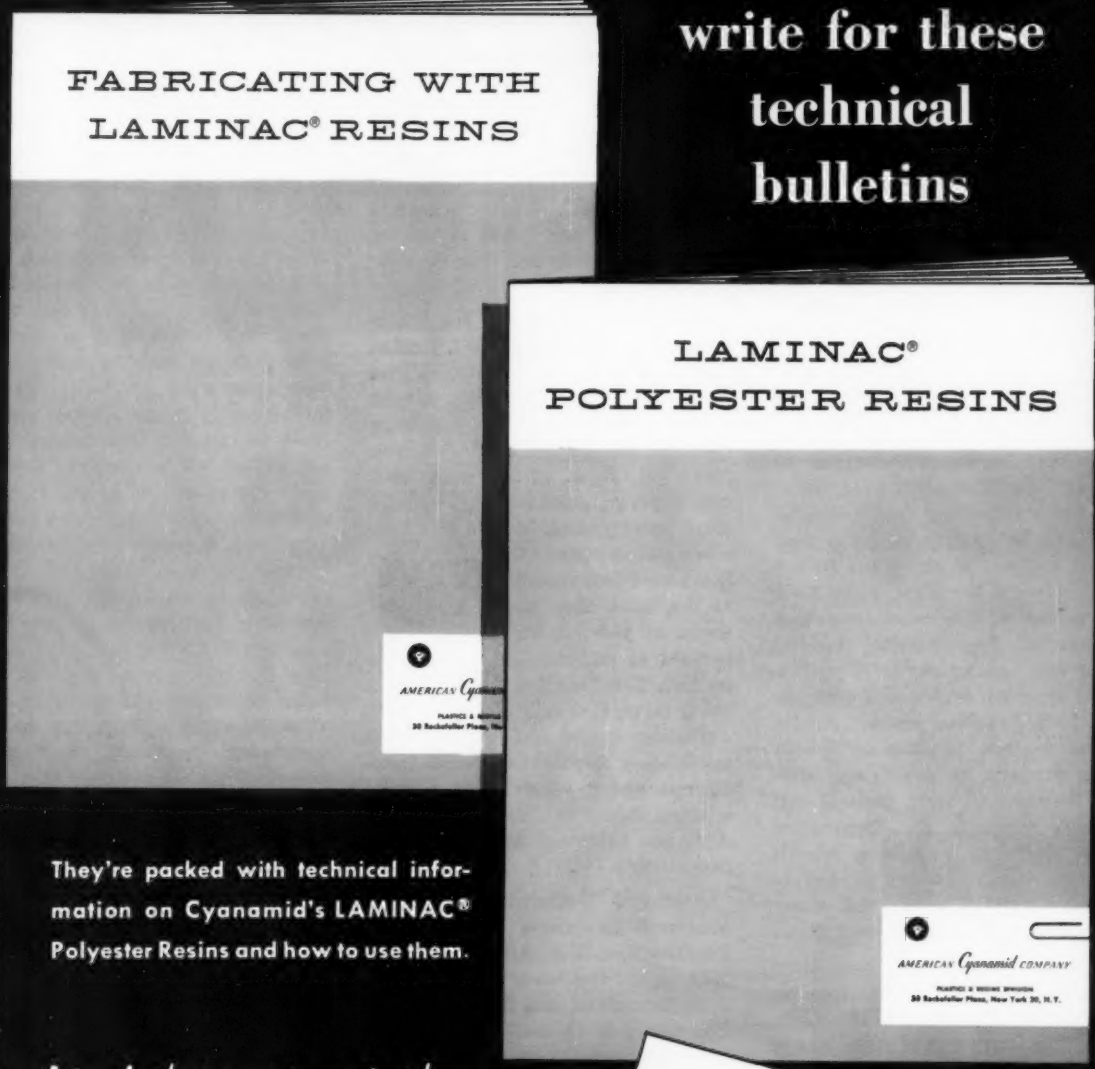
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PLASTICS DIGEST*

Abstracts from the world's literature of interest to those who make or use plastics or plastics products. For complete articles, send requests direct to publishers. List of addresses is at the end of Plastics Digest.

Materials

A Low Cost Injection Molding Material. K. Rose. Materials & Methods *40*, 144-146 (Oct. 1954). A low cost injection molding material with properties satisfactory for many purposes is described. The material is composed of asbestos fiber and a binder of asphalt or resin, the ingredients being combined in approximately equal proportions. Both the asphalt and the resin binder types have excellent resistance to mild acids, mild alkalies, salts, moisture and weathering; they are relatively low in strength but have good impact resistance; resistance to organic solvents is rather poor. Low cost is one of the most important features of the material; molded pieces may cost as low as 16 cents a pound or in the region of 1 cent per cubic inch of molded product. Applications include mechanical space-filling supports in packaging, window frames and sash, sealers, and resilient supports for automobile doors, electrical insulators, wheels for toys, picture frames molded to resemble carved wood, and many other large-quantity low-cost items.

Curing of Silicone Rubber With Benzoyl Peroxide. A. M. Bueche. J. Polymer Sci. *15*, 105-120 (Jan. 1955). The formation of crosslinks in benzoyl peroxide was studied by tension and swelling techniques as a function of curing conditions and filler content. The ability of benzoyl peroxide to form crosslinks was found to decrease markedly as the peroxide concentration was increased. The peroxide seems to form crosslinks in an amount independent of the concentration of the silica filler. High crosslink concentrations were found to be necessary to fully utilize the polymer-filler attachments. Values for the bulk and solution densities of silicone gum and the specific volume of the filler in silicones were determined. The melting point of benzoyl peroxide immersed in silicone gum is reported. The aging of silicone gum at 150° C. in air was found to neither increase nor decrease the number of crosslinks.

p-t-Butylstyrene and Its Polymers. L. L. Ferstandig, J. C. Butler, and A. E. Straus. J. Am. Chem. Soc. *76*, 5779-80 (Nov. 20, 1954). A new polymer made from *p-t*-butylstyrene has the highest heat distortion point (117.8° C. at 264 p.s.i. fiber stress) yet reported for alkyl-substituted polystyrenes. Similar test bars made from a commercial polystyrene had a heat distortion point of 88.0° C. at the same fiber stress. The synthesis of *p-t*-butylstyrene and the method of polymerizing it are described. The resulting polymers are hard, clear, and colorless with high molecular weight and low methanol solubilities. Copolymers made from styrene and *p-t*-butylstyrene show a straight-line relationship of heat distortion point and mole percentage composition.

Aromatic Polyhydrocarbons. I. Monomer Reactions and Polymer Preparation. L. A. Auspos, L. A. R. Hall, J. K. Hubbard, W. Kirk, Jr., J. R. Schaefgen, and S. B. Speck. J. Polymer Sci. *15*, 9-17 (Jan. 1955). Polyhydrocarbons were prepared by the dehydrogenation of 1,4-dimethyl substituted aromatic hydrocarbons and other related starting materials by several methods. A study was made of the intermediates formed and of their chemical reactions. II. Chemical and Physical Properties of Polymers. L. A. Auspos, C. W. Burnam, L. A. R. Hall, J. K. Hubbard, W. Kirk, Jr., J. R. Schaefgen, and S. B. Speck, *ibid. 15*, 19-29 (Jan. 1955). Hydrocarbon polymers prepared by the hot tube pyrolytic dehydrogenation of 1,4-dimethyl substituted aromatic hydrocarbons were studied and characterized as to chemical and physical properties. Tough, chemically resistant products were obtained, but fabrication of these polyhydrocarbons was difficult due to the relative intractability of the polymers obtained.

Molding and Fabricating

Bag Molding. D. L. Ridenour. SPE J. *10*, 35-39 (Dec. 1954). There are two general methods used in bag molding glass fiber-reinforced polyester laminates: pressure molding and vacuum molding. Pressures up to 50 p.s.i. are applied to the laminate in the former process, but the maximum pressure available by the latter process is about 14 p.s.i. This will result in glass contents of 35 to 40% using mat and 50 to 55% using cloth. The advantages of vacuum over pressure molding are: 1) the membrane need not be tailored to fit the mold; 2) the air and enough resin to result in satisfactory glass percentage will be removed through the vacuum outlets; 3) the removal of air, glass wet-out, and the time of cure may be easily checked with a transparent membrane; and 4) the mold need not be constructed to withstand high pressures. The construction of the molds and the auxiliary equipment are discussed. The latter includes bleeder ring and vacuum outlets, clamping frames, membrane materials, and mold heaters. Various methods of applying the resin are described and an example is given of the complete molding process.

Extruding With Twin Screw Extruders. A. J. Schaerer. Kunststoffe *44*, 601-607 (Dec. 1954). The twin screw extruder originally designed for extruding rigid polyvinyl chloride is now being used for practically all thermoplastic materials and serves at the same time as mixer-kneader and granulating machine. The extrusion methods for rigid and plasticized polyvinyl chloride, cellulose acetate, celluose acetate butyrate, polyethylene, and polystyrene are given. Five twin screw extruders are described in detail.

Applications

Vinyl-Coated Steel Housings for Business Machines. G. H. Kress. Elec. Mfg. *54*, 115-19 (Dec. 1954). Vinyl-coated steel has provided a number of valuable advantages as a housing for IBM machines, including ease and economy of fabrication,

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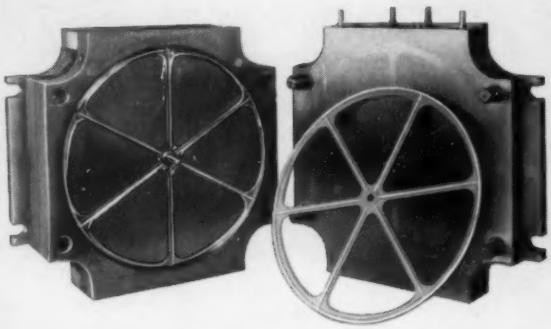

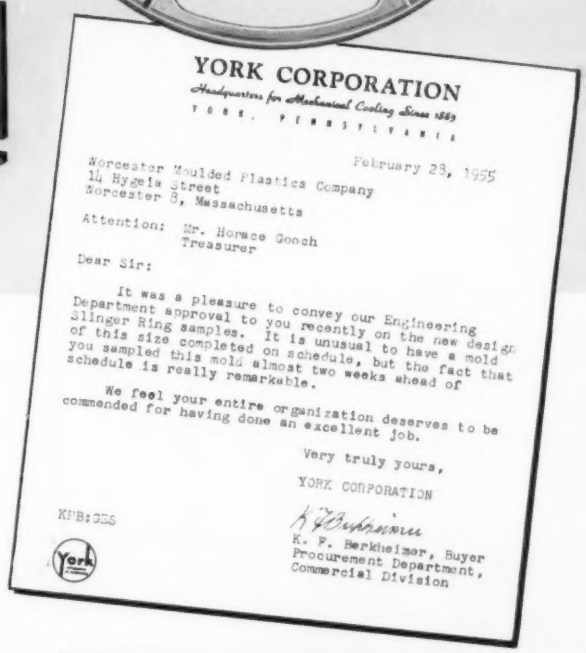

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utility and ease of maintenance, and aesthetic appeal. Vinyl-coated steel was adopted in preference to other materials such as stainless steel, decorative laminates, cellulose acetate butyrate, linoleum, and vitreous enameled steel after extensive tests of abrasion, acoustic, thermal, staining, and other factors. The characteristics, design problems, and applications of the vinyl-steel system are discussed.

ADHESIVES IN AIRCRAFT CONSTRUCTION. N. A. De Bruyne. Adhesives & Resins *2*, 148-53 (June 1954). The advantages of the reduction in weight and the simplicity of gluing are weighed against the stability and greater safety of riveting aircraft metal parts. Adhesives are being used for such applications as anchoring reinforcement strips, bonding helicopter blades, bonding between the inner corrugated skin and outer smooth skin of the leading edge of wings, and in the fabrication of honeycomb sandwich structures having smooth exteriors. The epoxy resins are good adhesives for aircraft construction applications. They are available as fusible solids and solventless liquids that do not produce volatiles during curing and do not require pressure. A phenol-formaldehyde polyvinyl-acetal adhesive requiring a curing temperature of 135 to 150° C. for 20 min. is finding wide use. A phenol-formaldehyde nitrile-rubber adhesive is available but gives lower shear strength than is obtained with the other two mentioned above. The aluminum alloys are prepared for bonding by degreasing in trichloroethylene and pickling and anodizing in chromic acid. Curing of the resin-bonded structures is accomplished by heating the components while they are held together in a suitable press.

A NEW INJECTION-MOLDING PROCESS FOR PRINTED RESISTORS. R. S. Marty, E. M. Davies, and P. J. Franklin. Elec. Mfg. *55*, 56-63 (Jan. 1955). A description is given of the equipment used, the formulation of resistor inks, the printing and curing procedures, the effect of formulation variables, and the effect of operational variables in a new injection-molding process for making printed resistors. The injection-molding printer described differs from the commercial machine primarily in the method of metering the ink and in the use of a resilient rather than a rigid matrix. The resistor ink was prepared by dispersing carbon in an epoxy resin, urea-formaldehyde, solvent mixture. Electrical properties were not significantly affected by using different epoxy or urea-formaldehyde resins or different solvents while maintaining the same basic formulation, but carbon type and concentration were important variables. Curing at higher temperatures for shorter periods of time resulted in resistors of better stability than cure at lower temperatures for longer periods. The longer the cure at an elevated temperature, the lower was the value of the resistance. Resistors given different cures but with their carbon-resin ratio adjusted to the same resistance did not differ in resistance-temperature characteristics, voltage coefficient, or noise. The electrical properties of a resistor vary with its physical dimensions;

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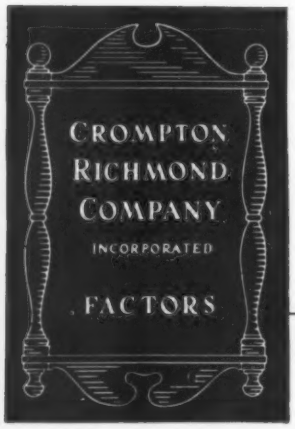

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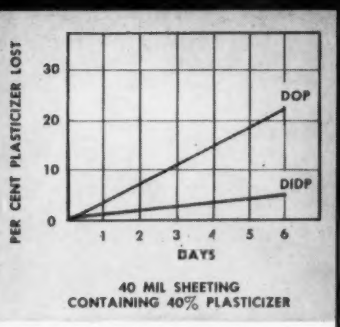

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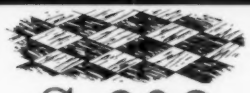

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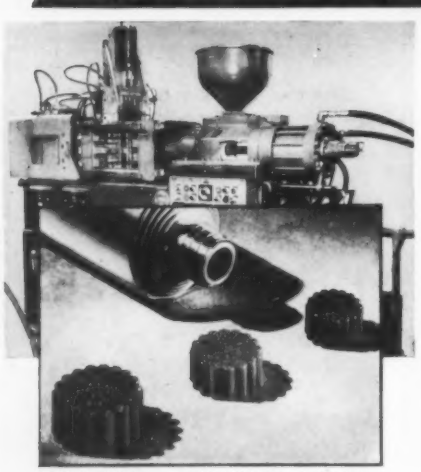

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applicable design considerations and formulas are discussed. Uncoated resistors stored in 95% relative humidity at room temperature for 250 hr. increased 10 to 15% in resistance. This can be reduced to less than 5% by a suitable coating. In either case, the resistors return to their original value when dried.

Coatings

KNOW THE CHEMICAL REACTIONS WHEN SPECIFYING ORGANIC FINISHES. M. Kronstein. Elec. Mfg. *54*, 98-102 (Nov. 1954). The chemical reaction in the baking oven largely determines the final characteristics of the protective coating or insulating varnish applied to a product, so that awareness of this reaction is often the key to a successful specification. For maximum heat and chemical resistance the coating material selected should be thermosetting, should not decrease considerably in ultimate chemical resistance as a consequence of the applied curing conditions, and should have a slow rate of moisture penetration during operation in relation to such factors as exposure time, humidity, and temperature. The resistance to moisture of the undercoat or primer and of the underlying base material should also be considered. Heat curing is essential for optimum coating properties but should not continue to the point where the cured film becomes embrittled.

Properties

UNUSUAL ORIENTATION PHENOMENA IN POLYETHYLENE INTERPRETED IN TERMS OF THE MORPHOLOGY. A. Keller, J. Polymer Sci. *15*, 31-49 (Jan. 1955). Various orientation phenomena of the drawing-relaxation behavior are interpreted in terms of the changes occurring within the submicroscopic helices that form the spherulites. Not only drawing and relaxation but also the redrawing of the relaxed samples were followed, and it is shown that the observed anomalous orientation effects cannot be described in terms of tilts of planes with simple indices. However, by considering also the possible shapes of the submicroscopic units these orientation effects can be visualized. A new general type of orientation, the "row orientation," is introduced. This arises when crystallization takes place while the melt is flowing. Flow produces lines of high nucleus

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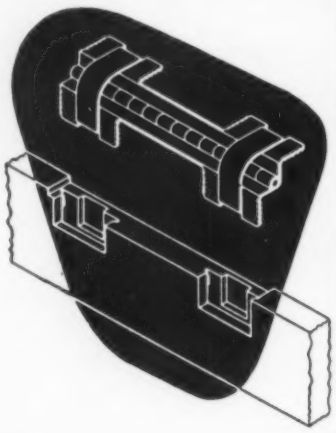

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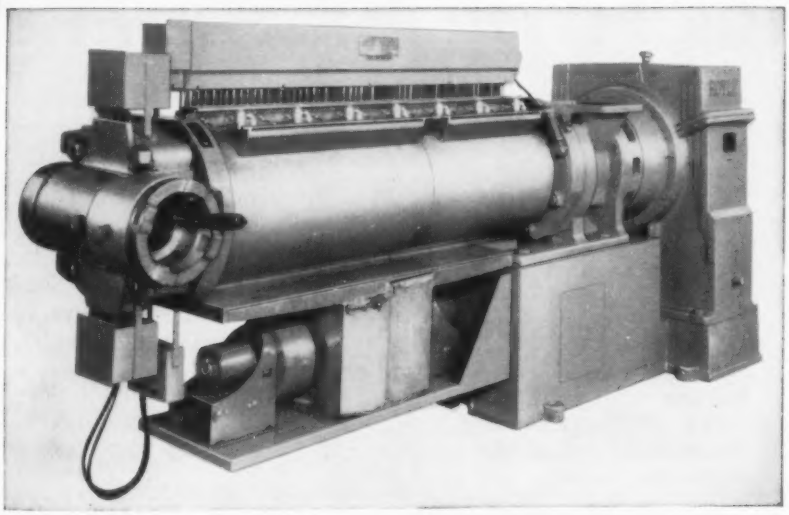

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density, leading to growth of the crystallites in all directions perpendicular to the direction of drawing. This results in elongated aggregates of helices, and the alignment of these complex units produces a unique type of orientation which is established from various angles.

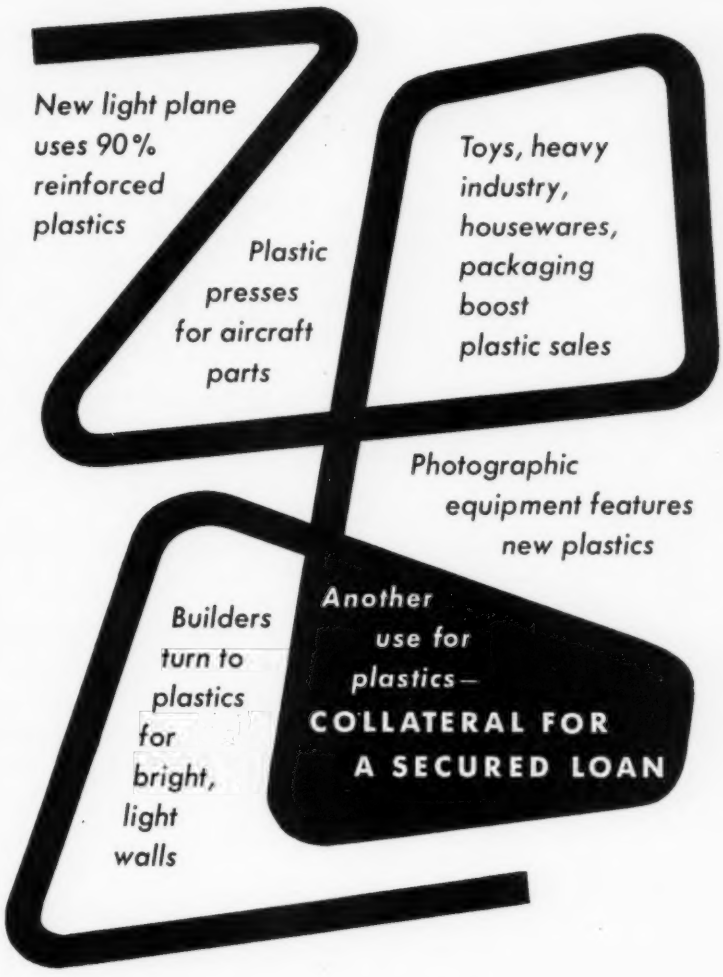
MECHANISM OF PLASTICIZER ACTION. E. Jenckel. Kunststoffe 45, 3-12 (Jan. 1955). Plasticizers are organic liquids added to rigid plastics to change them into somewhat tough materials. The addition of plasticizers changes the second order transition temperature. The "freezing-in" at the second order transition temperature occurs because the internal motion of the molecules decreases below a definite threshold value. The mechanism of the plasticizer action was, therefore, investigated from its effect on the second order transition point which was determined from volume changes. These volume changes were found from the refractive indices and the Lorents-Lorenz volume equation. Refractive index measurements were made on polymers of high and low molecular weights in the liquid and glassy phases over the whole concentration range from the pure polymer to the pure plasticizer. The result was a characteristic volume concentration in the glassy phase for which a molecular configuration is given.

Testing

RAPID IDENTIFICATION OF GLYCOLS IN ALKYD RESINS. C. B. Jordan. Analytical Chem. *26*, 1657-58 (Oct. 1954). A rapid method, which utilizes only standard laboratory equipment, was developed for qualitatively detecting vicinal glycols of low molecular weight in alkyd resins. It is based on reflux distillation, making use of a ternary azeotropic mixture formed by xylene, the glycols, and water, xylene being the refluxing medium.

Publishers' Addresses

Adhesives and Resins: A. S. O'Connor and Co., Ltd., 329 Grays Inn Rd., London W. C. 1, England.
Analytical Chemistry: American Chemical Society, 1115 Sixteenth St., N. W. Washington 6, D. C.
Electrical Manufacturing: The Gage Publishing Co., 1250 Sixth Ave., New York, N. Y.
Journal of the American Chemical Society: American Chemical Society, 1115 Sixteenth St., N. W. Washington 6, D. C.
Journal of Polymer Science: Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y.
Kunststoffe: Carl Hanser Verlag, Leonhard-Eck-Strasse 7, Munich 27, Germany.
Materials and Methods: Reinhold Publishing Co., 430 Park Ave., New York 22, N. Y.
SPE Journal: Society of Plastics Engineers, 513 Security Bank Bldg., Athens, Ohio.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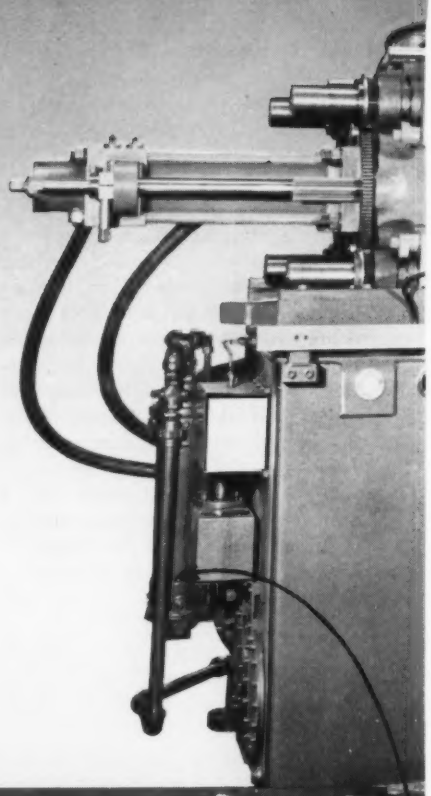

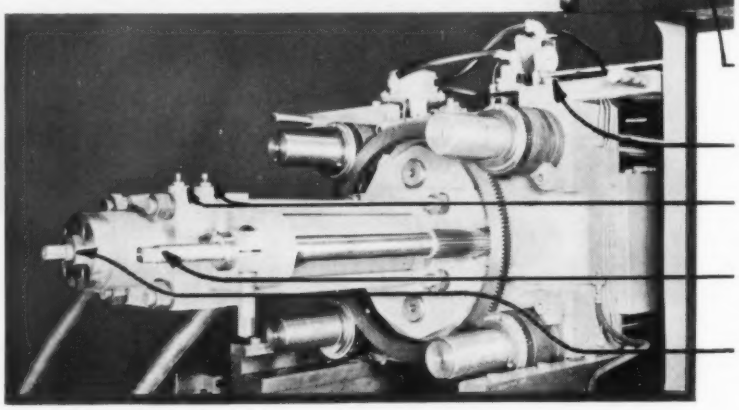

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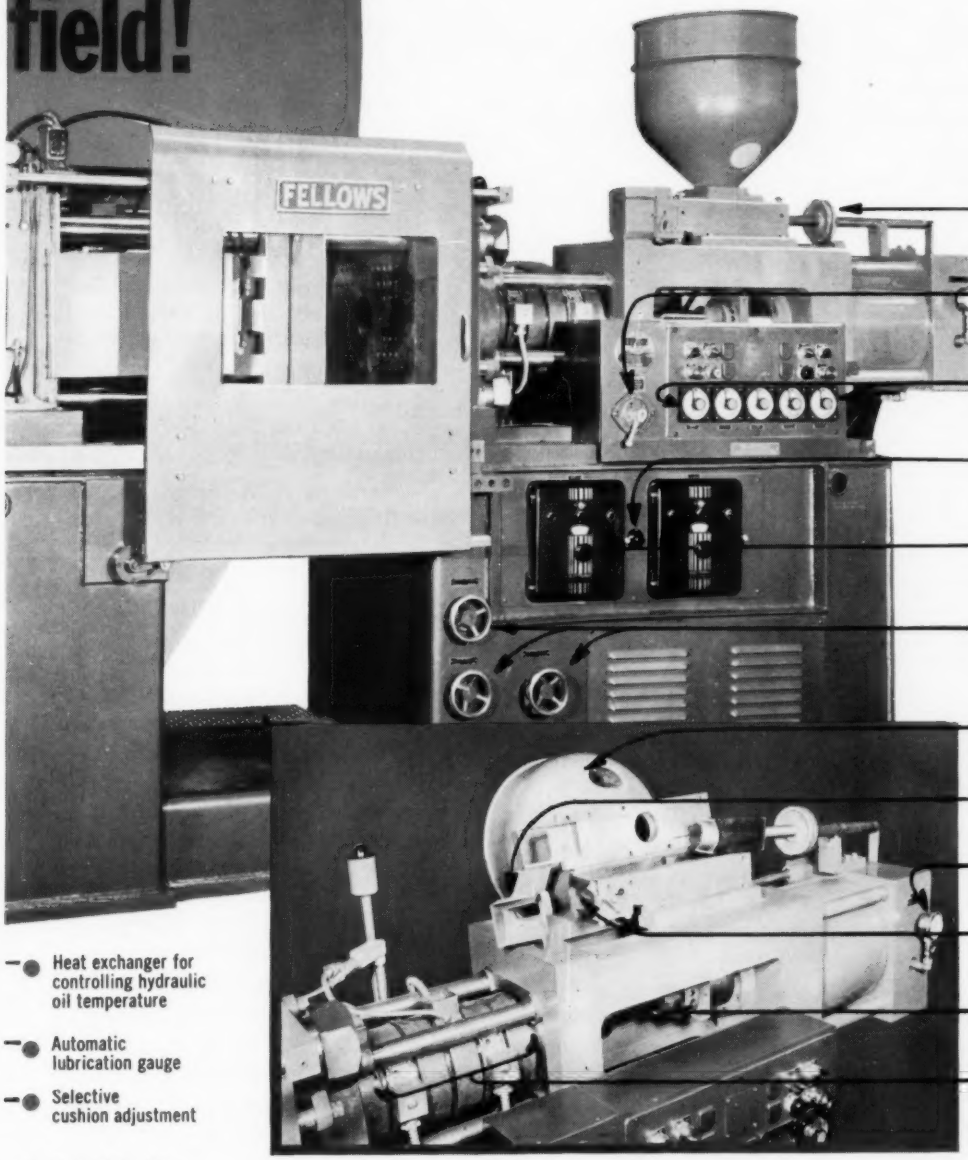

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U. S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

GASKET. N. L. Greenman and R. C. Berry (to Rogers). U. S. 2,698,788, Jan. 4. Mineral and cellulose fibers beater-treated with resins and rubbers.

COATING. A. G. Asaff (to Callaghan Hession). U. S. 2,698,807, Jan. 4. Ethyl cellulose composition.

CELLULAR PLASTICS. E. Simon and F. W. Thomas (to Lockheed). U. S. 2,698,838, Jan. 4. Heat-resistant oxalate-alkyd-isocyanate foams.

COPOLYMERS. S. E. Bradshaw and E. M. Evans (to British Resin Products). U. S. 2,698,839, Jan. 4. Copolymerization of styrene and drying oils.

COPOLYMERS. E. Dyer and G. A. Weisgerber (to Armstrong Cork). U. S. 2,698,840, Jan. 4. Copolymers of styrene and linoleic esters.

RESIN. J. F. McKay, Jr. (to Standard Oil). U. S. 2,698,841, Jan. 4. Reacting an olefin-diolefin resin with a cyclodiolefin.

FIBERS. J. B. Dickey, H. W. Coover, and T. E. Stanin (to Eastman Kodak). U. S. 2,698,842, Jan. 4. Fibers of acrylonitrile-alkyl alpha-acylamino acrylate copolymer.

MILLING. H. A. Swallow (to Carbide and Carbon). U. S. 2,698,962, Jan. 11. Apparatus for continuously milling plastics.

EXTRUSION. H. T. Tornberg (to Modern Plastic Machinery). U. S. 2,698,964, Jan. 11. Extrusion machine with pressure control means.

APPLICATOR. A. C. Radtke (to International Harvester). U. S. 2,698,-965, Jan. 11. Application of coatings to glass filaments.

MOLDING. L. L. Stott and L. R. B. Hervey (to Polymer). U. S. 2,698,-966, Jan. 11. Producing shaped polyamide articles.

POLYMERIZATION. H. P. Callahan and D. G. Jordan (to American Cyanamid). U. S. 2,698,968, Jan. 11. Polymerization process and apparatus.

SCREEN. H. F. Mesick, Jr. (to General Electric). U. S. 2,698,991, Jan. 11. Glass-reinforced plastic radiographic intensifying screen.

STENCIL. K. S. Hoover (to A. B. Dick). U. S. 2,699,113, Jan. 11. Thermosensitive plastic stencil screens

COATING. J. D. Braudner (to Atlas). U. S. 2,699,400, Jan. 11. Cellulose nitrate plasticized with di-(betaphenoxyethyl) diglycolate.

REFLECTIVE SHEET. G. Meyer (to Eastman Kodak). U. S. 2,699,402, Jan. 11. Plastic articles with reflective metallic surfaces.

COATINGS. C. R. Martens and J. G. Bellamy, Jr. (to Sherwin-Williams). U. S. 2,699,407, Jan. 11. Resin coatings for metals to increase thermal resistance of the metal.

PLYWOOD. L. Repsher and S. Pedicini (to Carbide and Carbon). U. S. 2,699,417, Jan. 11. Aluminum foil covered plywood bonded with phenolic resin.

COMPOSITION. M. T. Harvey and P. L. Rasamilia (to Harvel). U. S. 2,699,431, Jan. 11. Composition of a rubber and an acetone-formaldehyde resin.

PLASTICIZER. K. H. W. Turck (to Distillers). U. S. 2,699,434, Jan. 11. Vinyl chloride polymers plasticized with di-2,4,4-trimethylpentyl phthalate.

RESINS. R. W. Auten and R. S. Yost (to Rohm and Haas). U. S. 2,699,435, Jan. 11. Polyhydroxypolyalkylene - polyurea - formaldehyde condensates.

POLYMERS. G. F. D'Alelio (to Koppers). U. S. 2,699,436-7, Jan. 11. Polymers of dialkylamino aryl itaconamides.

POLYESTERS. L. H. Bock and J. K. Anderson (to Rayonier). U. S. 2,-699,438, Jan. 11. Linear polyesters of carboxy-2-hydroxymethyl benzodioxane.

MOLDING. C. E. Gilbert (to Gilbert Manufacturing). U. S. 2,699,574, Jan. 18. Molding machine.

ADHESIVE DISKS. H. H. Mahler. U. S. 2,699,999, Jan. 18. Coated plastic adhesive wafers.

TEXTILE FINISH. O. P. Cohen and M. J. Scott (to Monsanto). U. S. 2,700,001, Jan. 18. Textile material with antistatic finish

LAMINATED WINDSHIELD. B. J. Dennison and W. G. Smith (to Pittsburgh Plate Glass). U. S. 2,700,007, Jan. 18. Shaping plastic interlayer for curved laminated windshield.

GLASS FABRIC. E. H. Balz (to Glass Fibers). U. S. 2,700,010, Jan. 18. Acid treating glass cloth prior to lamination.

LATICES. C. L. Dibert (to Dow). U. S. 2,700,026, Jan. 18. Plasticized polymer latices.

POLYMERS. H. A. Bruson (to Industrial Rayon). U. S. 2,700,027, Jan. 18. Compositions of acrylonitrile and chloro-allyl tertiary amine.

RESINS. C. H. Jarboe (to Du Pont). U. S. 2,700,028, Jan. 18. Modified polyvinyl acetal.

POLYMERS. H. G. Cassidy. U. S. 2,700,029, Jan. 18. Vinyl hydroquinone polymers.

RESINS. T. Boyd and H. A. Walter (to Monsanto). U. S. 2,700,031-2-3, Jan. 18. 2-Keto-5-imino-4-amino-4-ureido-imidazolidine aldehyde resins.

POLYVINYL ALCOHOL. J. E. Bristol (to Du Pont). U. S. 2,700,035, Jan. 18. Production of polyvinyl alcohol.

CASTING. M. M. Lee (to U. S.). U. S. 2,700,185, Jan. 25. Thermoplastic casting compositions

INSULATOR. E. J. Flynn and G. W. Young (to General Electric). U. S. 2,700,212, Jan. 25. Polychlorotrifluoroethylene insulator for a conductor.

PLASTICIZER. M. L. Fein, W. P. Ratchford, E. M. Filachione, and C. H. Fisher (to U. S.). U. S. 2,700,-616, Jan. 25. Acylated lactamides as plasticizers for vinyl resins.

PLASTICIZER. K. Henkel, W. Gündel, and A. Kirstahler (to Henkel).

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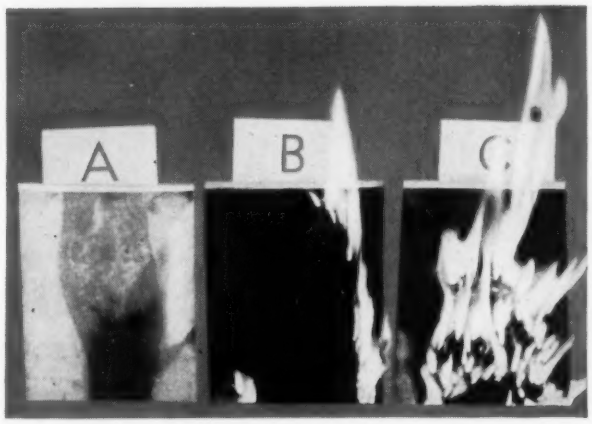
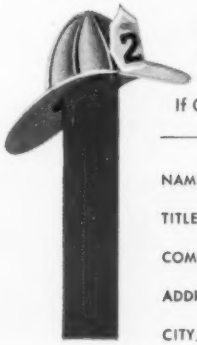


FLAME RETARDANCY TEST. 3 lacquers were formulated using same basic formula with exception of plasticizer. In Case A, it was Celluflex CEF (tris β-chloroethyl phosphate); Case B, tricresyl phosphate; Case C, dibutyl phthalate.

Lacquers were sprayed on panels, then ignited for 7 seconds. Upon removal of flame, Panel B and C continued to burn but Panel A (Celluflex CEF lacquer) extinguished itself within 2 seconds!

Celanese* CHEMICALS

*Reg. U.S. Pat. Off.



Celanese Corporation of America
Chemical Division, Dept. 577-E
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If Celluflex CEF can be useful in _____
_____ send me test sample and technical literature.

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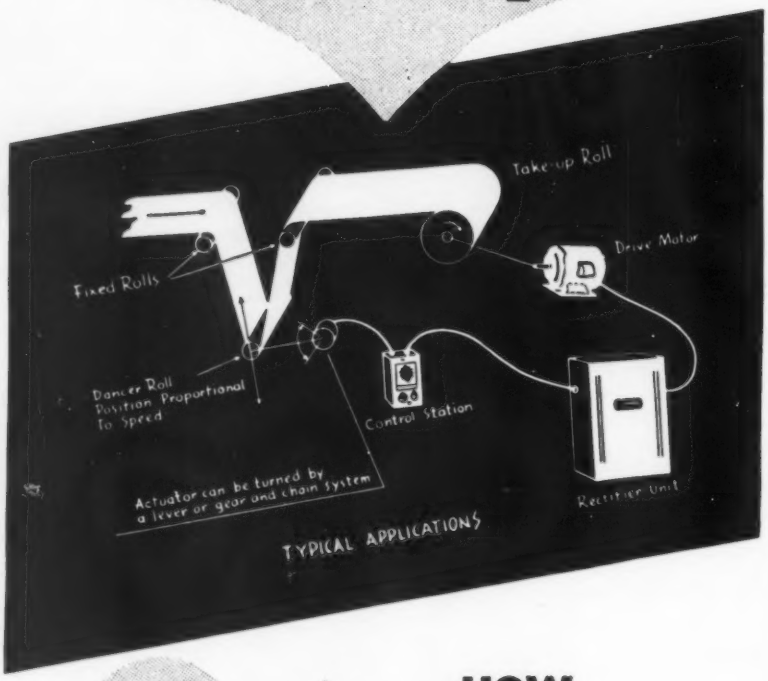
Servospeed

Automatic Take-Up



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A small tension change positions the actuator shaft so as to call for motor speed change to restore preset tension. Thus a constant linear feet per minute windup may be achieved even though the radius of takeup roll increases with each turn to otherwise increase linear speed versus radius build-up. Speed is now made proportional to position of dancer roll and tension is held essentially constant, as is the linear rate of material travel.

These and other models of electronic motor speed control systems available from 1/50th to 2 horsepower.

WRITE

Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave. Paterson, N. J.

U. S. 2,700,617, Jan. 25. Acetyl cellulose plasticized with an alkylbenzolsulfamide.

INSOLES. T. C. Morris and E. A. Chandler (to B. B. Chemical). U. S. 2,700,625, Jan. 25. Insole of polyvinyl resin.

VINYL RESIN SHEET. J. R. Bukey and A. G. Smolka (to Firestone). U. S. 2,700,630, Jan. 25. Vinyl leather products.

COATING. W. C. Ferguson and P. Sussenbach (to Presstite). U. S. 2,700,631, Jan. 25. Extruded coatings.

INSULATION. H. P. Bovenkerk (to General Electric). U. S. 2,700,633, Jan. 25. Glass fiber insulation.

LAMINATING. E. Ackerlind (to Northrop Aircraft). U. S. 2,700,634, Jan. 25. Laminated cellular core structures.

POLYVINYL RESINS. W. S. Emerson and R. I. Longley (to Monsanto). U. S. 2,700,656, Jan. 25. Polyvinyl chloride plasticized with a diester.

POLYMERS. F. K. Signaigo (to U. S.). U. S. 2,700,658, Jan. 25. Polymeric (*n*-butoxymethyl)-ethylene polysulfide.

INTERPOLYMERS. E. Mueller (to Badische-Anilin). U. S. 2,700,660, Jan. 25. Interpolymerization products of vinyl isobutyl ether and higher olefins.

POLYMERS. W. T. Miller. U. S. 2,700,661, Jan. 25. Halocarbon polymers.

POLYMERIZATION. D. M. Young and B. Thompson (to Carbide and Carbon). U. S. 2,700,662, Jan. 25. Polymerizing chlorotrifluoroethylene with bis-heptafluorobutyl peroxide.

POLYMERIZATION. E. F. Peters (to Standard Oil). U. S. 2,700,663, Jan. 25. Polymerization of low molecular weight olefins with acetylene treated molybdena catalysts.

BATTERY CASE. H. A. Gottschall (to U. S.). U. S. 2,700,695, Jan. 25. Plastic battery case.

MOLDING COMPOUND. A. M. Howald and G. B. Rhinefrank (to Glaskyd). U. S. 2,701,054, Feb. 1. Plastic reinforced with a rope-like filler.

ZIPPERS. G. F. Hetzel and H. A. Wilhelm (to Brown and Bigelow). U. S. 2,701,222, Feb. 1. Attaching zippers to a plastic body.

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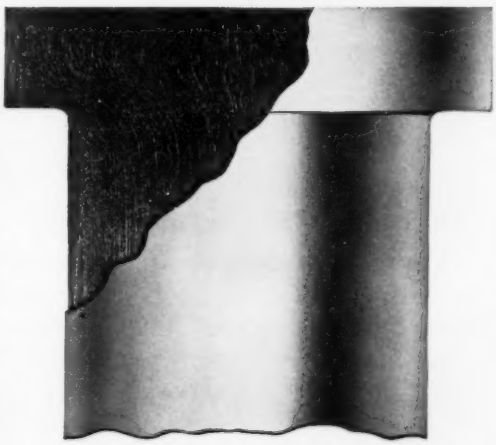

CROSS-SECTION OF D-M-E EJECTOR PIN SHOWING FLOW-LINE PATTERN. PHOTO-MICROGRAPH ENLARGEMENT MADE BY THE DETROIT TESTING LABORATORY.

COMPLETE DATA ON PAGE 142 AND 143 OF THE D-M-E CATALOG. OR . .

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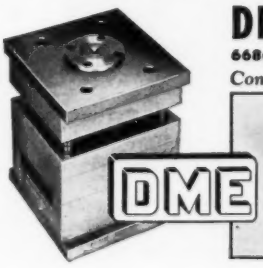

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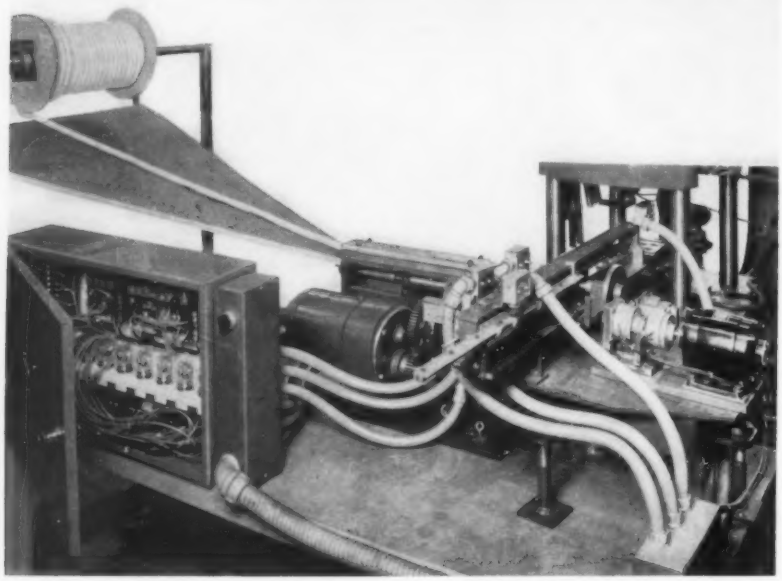
NEW MACHINERY AND EQUIPMENT

Automatic Plastic Rope Cutter-Feeder—Equipment is especially designed to operate in conjunction with Baker's high-speed, fully automatic alkyd compression molding press and is said to overcome problems peculiar to molding rope-type glass-reinforced molding compound.

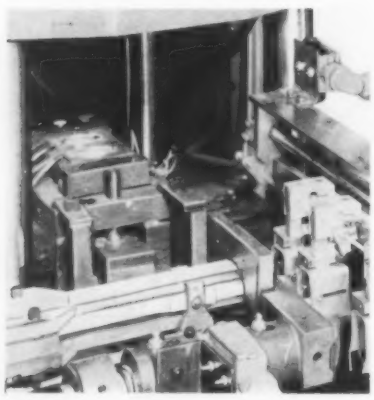
One way in which glass-filled alkyd molding material is supplied to the molder, is in the form of uniform cross-section rope of various diameters, coiled on spools. Purpose of the automatic cutter-feeder unit is to measure the proper length of this rope, cut it and maintain uniformity, and transport it to the mold cavities. The unit can be adjusted to cut different lengths of rope, according to the charge required by the mold.

The spool of fibrous glass-filled rope molding compound is mounted on ball bearings so that it unwinds easily for trouble-free operation. The rope is gripped and fed into a knife, where it is cut. Care is taken not to damage the rope where it is gripped by the jaws. The blade is so designed that it cuts the putty-like material without major distortion and without tearing the remainder of the rope. The charge which has been cut off drops into a bucket, which in turn moves along until it is over the cavity, at which point the charge is dropped into the cavity; up to eight buckets can be utilized in this fashion—and all this without changing position of the material in order to assure that the fibers will run in the correct direction for maximum strength.

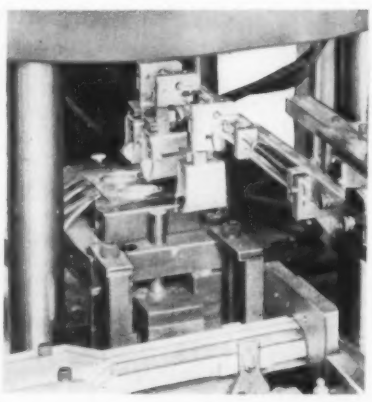
Operation of the unit is fully synchronized with that of the automatic molding press. *Baker Brothers, Inc., P.O. Box 101, Station F, Toledo 10, Ohio.*



Baker Brothers' automatic cutter and feeder handles glass-filled rope molding compound



Close-up of feeder-cutter; buckets are in position to receive cut-off lengths of glass-filled rope molding compound



Buckets filled with proper charges have moved to position above mold cavities, will deposit charges into them

Two-Stage Grinder—Model M400 grinder uses two cutting chambers mounted vertically one above the other and a 10-hp. motor to process material at a rate said to equal that of four equivalent conventional 10-hp. grinders.

The unit has an 11- by 17-in. throat opening. A 1¼-in. screen is suggested for the upper chamber and a ¼- or $\frac{5}{15}$-in. screen on the lower chamber. Both screen assemblies are readily removed for cleaning of cutting chambers. Provision is made for a full-size material drum to be placed under the lower cutting chamber; the unit is also available with a low base for floor level feeding. *Injection Molders Supply Co., 3514 Lee Rd., Cleveland 20, Ohio.*

Calender — Three-roll calender especially adapted for coating operations is of the 120° type, in which the top roll is moved 60° from the vertical plane. The tilt thus obtained is said to make the top bank much easier to feed than with a conventional, vertical three-roll calender; it also reduces the effect of center roll deflection on work being done in bottom pass. The calender can be

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H-250

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FASTER PRODUCTION—Will attain up to 720 cycles per hour (dry run).

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ACCESSIBILITY— Due to simple platen clamp device for purging to change material or color.

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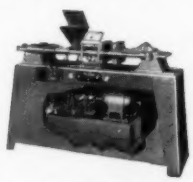

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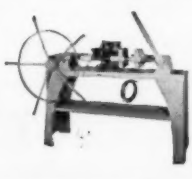

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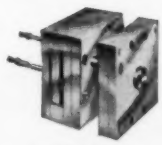
PLASTIC GRINDER
Grinds up rejects, waste, etc., for re-use.



MOLD BASES
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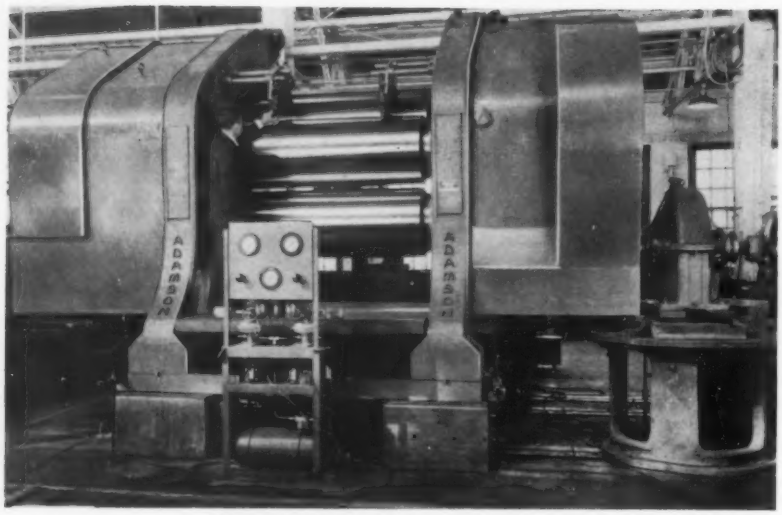


Adamson United's three-roll calender has top roll moved 60° from vertical plane

equipped with a motorized crossed-axis device for the offset roll; conventional screw adjustment or hydraulic cells can be used on the bottom roll for applying pressure in the coating pass. The unit is available in the 24- by 28-in. size. *Adamson United Co., 730 Carroll St., Akron 4, Ohio.*

Temperature Indicating Controller—Series 540 Controller is a remote indicating temperature control instrument designed for general industrial use. Actuated by a liquid-filled bulb and bellows, it has a temperature range of 100 to 700° F. Temperature differential is adjustable between 1 and 4% of scale temperature ranges by internal adjustment of pilot contacts. The unit automatically compensates for ambient temperatures between 50 and 150° F. Capillary tubes of 6 and 10 ft. are standard, other lengths are available on special order. The unit may be flush or surface mounted. *Fenwal, Inc., Ashland, Mass.*

Profile Tracer—Attachment is claimed to duplicate turnings with exact precision on any number of pieces. The profile tracer can be attached to any standard wood lathe with two bolts and allows centerless turning of either rod or bar stock of all types of plastics; facing, fluting, and reeding can also be done.

Duplication is accomplished by using the attachment in conjunction with templets, cut from blank aluminum stock with ordinary household shears (cutting can be done by unskilled operators). The templet is bolted to the attachment and the pattern is duplicated by the tracing mechanism. *Turnomat Co., Inc., Brockport 15, N. Y.*

Pin Hole Detector—Rapid pin hole inspection of electrical non-conducting film or sheet is made possible with the Model K-1 detector. The unit comprises an adjustable d-c power supply which is continuously variable from 0 to 7.5 kv.; a ground return (signal ground) has an indicating circuit that will count the number of spark discharges that have occurred from an inspection electrode, and this record is displayed on a magnetic-type counter.

In operation, the d-c output voltage from the detector is connected to an electrically conductive roller or brush-type electrode which is placed on the film to be inspected. The roller or brush is placed over an electrically conductive second roller and the film to be tested is run between the top and bottom rollers or contactors. A return lead is made from the bottom roller to the signal ground on the detector. Then, a d-c voltage, sufficiently high to jump an air gap slightly in excess of the film thickness is applied to the electrode combination. As the film passes between the electrodes, pin holes will cause a spark to jump between the top and bottom rollers and this spark discharge is recorded at a rate up to 1000 counts per minute. The unit is not intended for dielectric strength tests, but only for 100% inspection.

The detector is said to count spark discharges from 600 to 7500 v. of applied d-c potential. Provision is also made for external connection to a signal light or bell which operates from a 117-v. a-c source. *Tinker & Rasor, 203 Del Mar Place, San Gabriel, Calif.*

Granulator—Model M-1000, first machine to be made available in the Marvel series of granulators, is a beside-the-press granulator with a capacity of up to 200 lb./hour. A double-shear knife action is said to make possible the granulation of all plastics, including elastomerics, without fluffing. Hot and cold sprues can be fed to the unit simultaneously.

Hopper height is 49 in., throat opening is 8 by 8 in.; a 1½-hp. motor and starter is supplied with the equipment; 2- or 3-hp. motors are optional. *Ball & Jewell, Inc., 22 Franklin St., Brooklyn N.Y.*

Bonding Machine—Designed especially for use with plastics, 14-ton, 30-kw. bonding machine is said to provide permanent edge-bonds and to eliminate deflections of any kind. The unit is equipped with an automatic tuning control which maintains a full and constant electrical heat load between electrodes as the demands for heat change in the bonding process. *The Bell Machine Co., Oshkosh, Wis.*

Injection Machine—Model K is a 4-oz., horizontal, fully automatic injection molding machine. It has a low-pressure clamping mechanism that stops the machine if anything is caught between the mold faces when the machine is closing, setting off an alarm. Mold clamp is fully hydraulic and has adjustable snubbers at both ends of its stroke. Nozzle is adjusted hydraulically to the sprue bushing. The machine can also be operated manually and semi-automatically.

Model K comes equipped with motor, timers, heat control instruments with proportioning devices, motor starter, heater relays, and solenoid relays. Motor starter, heater relays, and solenoid relays are all mounted in a box at the rear of the machine, together with the fuses. The machine is equipped with a

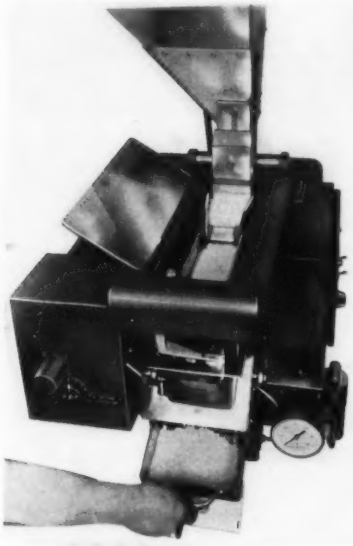
water manifold at the rear, terminating in a sight feed box, providing visual indication of the amount of water passing the molds or any part of the machine.

Specifications for Model K are as follows:

Injection capacity/shot (oz.) 6
Plasticizing capacity (lb./hr.) 70
Cycles/min. (dry run) 8½
Max. mold size, hor. (in.) 14 by 20
Max. mold size, vert. (in.) 12 by 22
Min. mold thickness (in.) 8
Mold opens (in.) 10
Mold clamping pressure (tons) .100

De Mattia Machine & Tool Co., Clifton, N. J.

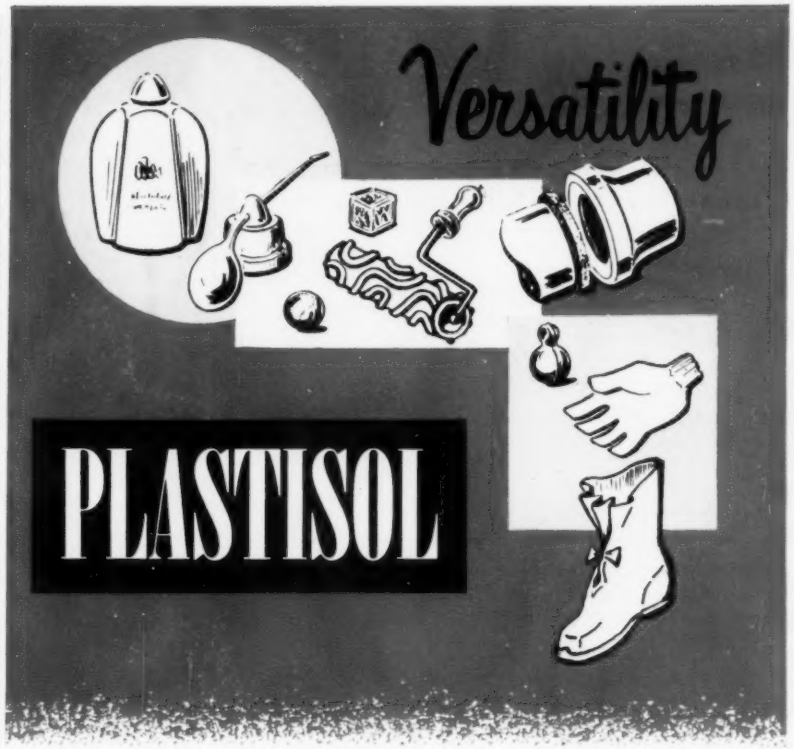
Weigh Feeder—Changes in material density, flowability, feed rate, voltage, and vibrations are claimed to have little or no effect on the accuracy of the Pneumatron weigh feeder. In operation, weight of the material deflects a cantilever assembly in the weighing head, causing



Pneumatic Scale's automatic feeder has provision for manual checking of measured load of molding material

an air control block to descend over an air jet, creating back pressure. This slight pressure is amplified and relayed to release an air cylinder latch, cutting off the flow of material. Dial-controlled bevel gears are provided for fine adjustments in weight. An accuracy of ±1/100 oz. is claimed for the unit.

The feeder has an automatic weight adjustment actuated from the



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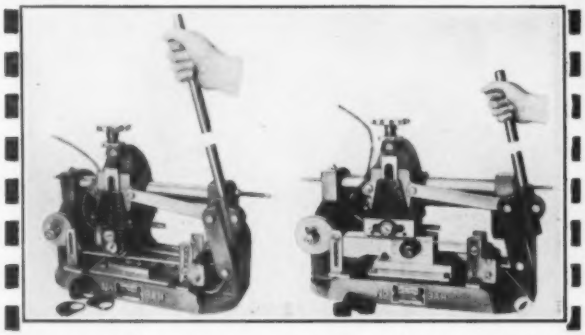

These machines use a roll die to mark flat parts and flat dies to mark tubes and round parts. The motor driven models are the last word in high production plastic parts marking.

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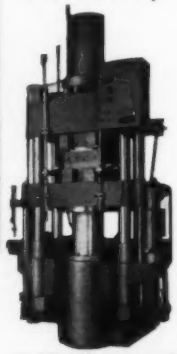

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"set-point" controlled by the position of the injection plunger to synchronize weight of input charge with output piece. A hinged section at the front of the discharge funnel is provided for manual checking of measured load. Weighed load will not discharge if press cylinder is over-full. *Pneumatic Scale Corp., Ltd., Quincy 71, Mass.*

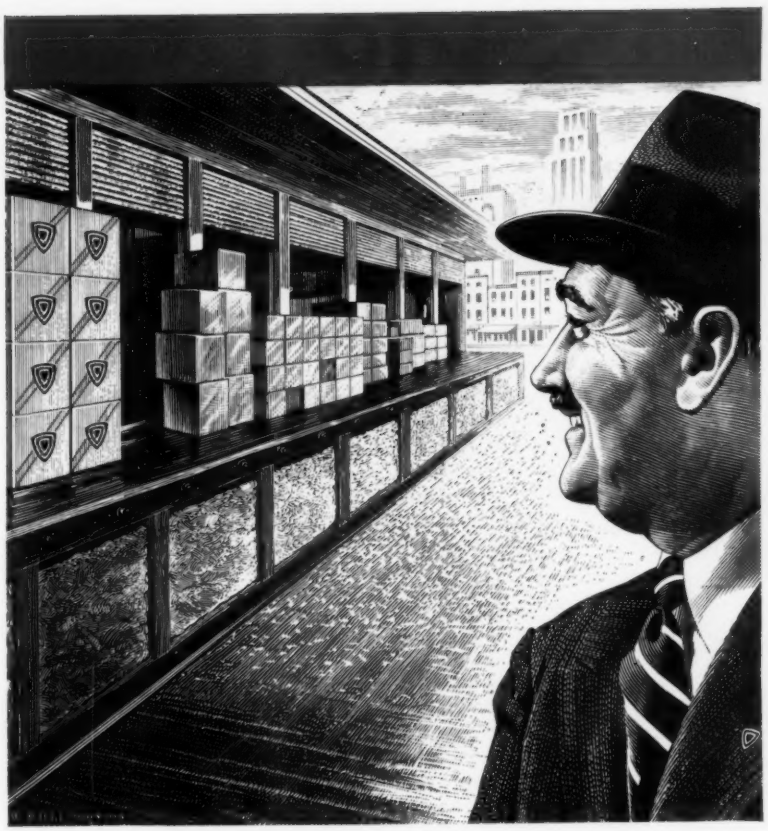
Slitting-Winding Machine—Model 400 slitting and roll winding machine for use in converting plants and finishing rooms has a rewind capacity of 30-in. diameter and a claimed running speed of 1000 ft./minute. It has provisions for changing from one slitting method to another, viz.: either pneumatic or spring lever score-cut and shear cut or razor cut. For pneumatic score-cut slitting, the unit has an element incorporating a straddle-mounted wheel.

For winding smaller than 30-in. diameter rolls, Model 400 is equipped with an automatic stop; a built-in, electrically operated riding roll lift; rewound roll ejector; and rewind shaft injector. When using small-diameter cores, the winder can be equipped with auxiliary midget riding roll for tight wrap at start of operation.

Main drive has no gears but uses tooth belts and grooved pulleys. The drive is also equipped with a simple speed controller to assure optimum running speed for whatever material is being processed. *Cameron Machine Co., 61 Poplar St., New York 1, N. Y.*

Feeders—Injection molding machine weigh-feeders are fully enclosed by plastic-metal housing to eliminate contamination of molding material. Two sides of the weigh-feeding mechanism are enclosed with metal walls, the remaining two sides with sturdy, clear plastic doors. Fastened with locks that prevent any "adjustments" of feeder by unauthorized persons, the doors provide unobstructed visibility of scale indicator that registers weight of every charge, as well as access to the feeder to change settings.

Four models are available: the smallest size has a 28-oz. charge capacity with a 100-lb. supply hopper; the largest has a 6¾-lb. charge and 350-lb. hopper capacity. *Exact Weight Scale Co., 944 W. Fifth, Columbus, Ohio.*



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BOOKS AND BOOKLETS

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"Materials of Construction," by A. P. Mills, H. W. Hayward and L. F. Rader; 6th ed.

Published in 1955 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 650 pages. Price: $7.50.

Manufacture, properties, and uses of materials of engineering construction constitute the subject matter of this textbook. Of particular interest are the chapters on plastics materials, laminates and adhesives, and organic protective coatings. Other materials discussed include metals, building stones, cementing materials, concrete, brick and clay products, and timber. The consideration of each material or class of materials is prefaced by a discussion of its ordinary applications in engineering construction, followed by a study of its manufacture or natural occurence, and concluded by a discussion of physical and mechanical properties in relation to uses. Review questions are included at end of each chapter. A section on definition of terms is also presented.

"Handbook of Textile Fibers," edited by Milton Harris

Published in 1954 by Harris Research Laboratories, Inc., 1246 Taylor St., N. W., Washington 11, D. C. 356 pages, 400 tables, 100 graphs, 140 photomicrographs and X-ray diagrams. Price: $12.50.

This comprehensive collection of data on textile fibers contains information on many new synthetic products as well as older natural fibers. It is based on experience accumulated by this well known textiles research organization. Tables and graphs cover the mechanical, optical, electrical, thermal, and frictional properties and the chemical and biological resistances of the various fibers. Other chapters deal with structure, microscopic examination, X-ray diffraction characteristics, identification, and economics. A 53-page section presents definitions of textile terms and lists common names, trademarks, and sources of fibers. The editor and his associates have produced a very useful reference work, well illustrated and indexed.—*G. M. K.*

"Paint and Varnish Manual," by P. L. Gordon and R. Gordon

Published in 1955 by Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. 182 pages. Price: $3.50.

A practical introduction to laboratory practices in control and development laboratories of the paint and varnish industry, addressed to students of chemistry or chemical engineering and technicians entering the field or engaged in related industries. Analytical methods pertinent to the preparation and evaluation of vehicle intermediates (oils, resins, varnishes) and formulation and application of the paints themselves are presented. Over 60 experiments (ranging from effect of temperatures on the bodying of oils to exercises in paint analysis) and over 30 test procedures (from determination of viscosity to determination of pigment percentage) are presented in detail.

Ion exchange—What ion-exchange resins are, how they were developed, and where they find application is discussed in this 12-page booklet. Some of the uses include water treatment, sugar refining, purification of industrial solutions, and medical therapy. *Chemical Process Co., Redwood City, Calif.*

Fillers—Possibilities of cost reduction with minimum effect on physical properties by using precipitated calcium carbonates in filling vinyl chloride resins are suggested in Technical Service Bulletin W-2. Typical physical properties obtainable with the fillers are described. *Witco Chemical Co., 260 Madison Ave., New York 16, N. Y.*

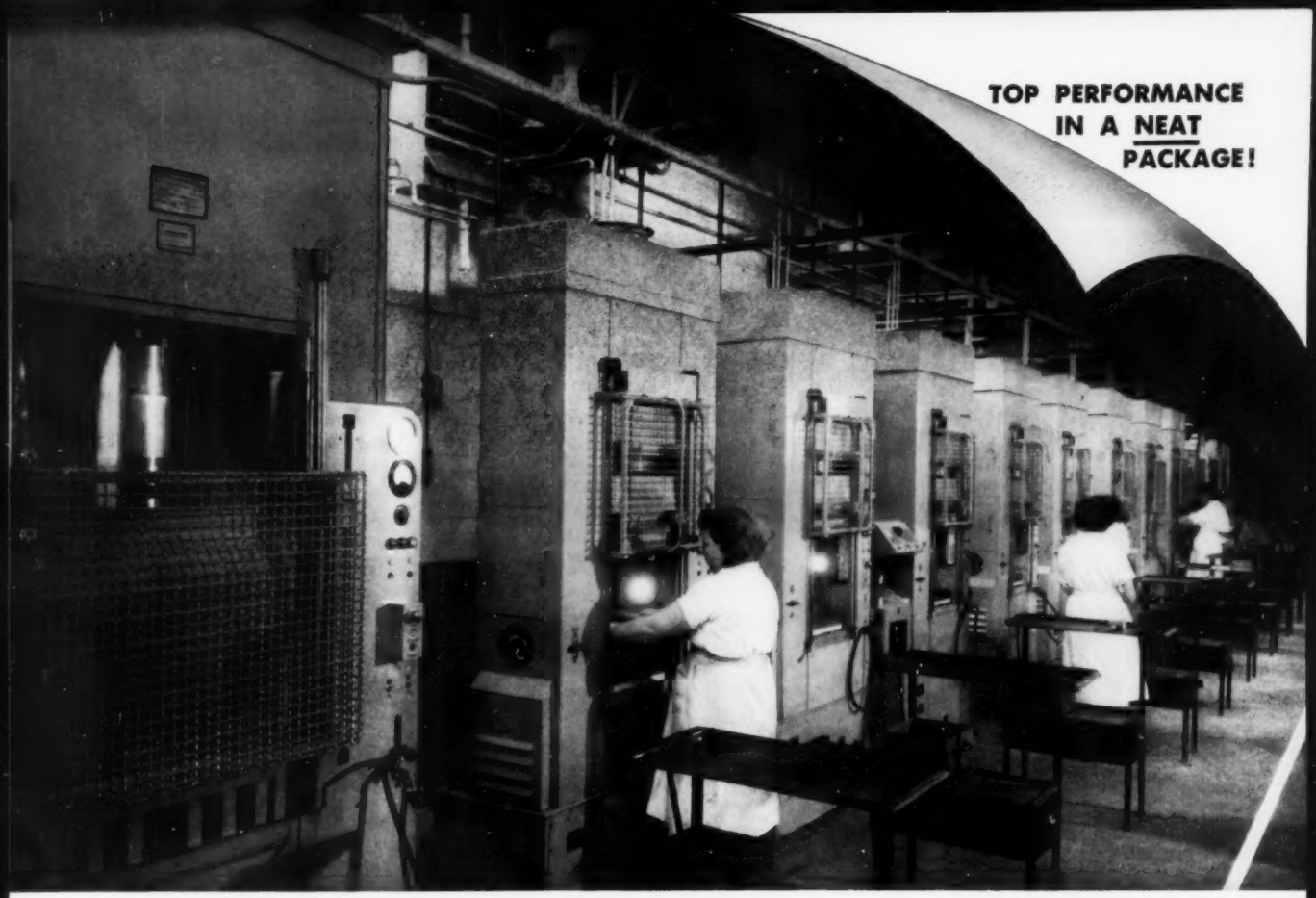
Automation—Some 87 words and phrases used in automation work, all of which had their origin with the engineers but are now creeping into the lexicon of modern businessmen, are defined in this "Automation Dictionary." Lest their engineering brethren cry "treason," the authors of the dictionary carefully point out that it was primarily designed "for those whose knowledge of automatic control is largely limited to the setting of the thermostat on the living room wall." *Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia, Pa.*

Surface-active agents—Folder 220 contains detailed specifications, as well as chemical, physical, and physiological properties of a line of surface-active agents. Information on use and compounding is included. The chemicals find application in a variety of industries, including paint, rubber, paper, leather, fur, metal, petroleum, glass, cement, textile, insecticide, drug and cosmetic, cleaning, and others. *Mona Industries, Inc., Chemical Div., Patterson 4, N. J.*

Welded polyethylene—The methods available for testing defects in polyethylene welds, both inherent and environmental, are described in this brochure. While each of these methods has its particular advantages, the most complete examination of a weld would be given by a combination of three tests: 1) a spark test for porosity; 2) a radiographic negative where necessary; and 3) a test for detrimental environmental effects according to a special test method which is specific for each application. *American Agile Corp., P. O. Box 168, Bedford, Ohio.*

Winding equipment—Five models in a line of winders, typical installations, and typical companion winding machinery for webs and strands are described in this 12-page brochure. The machinery is designed to provide integrated installation for winding, rewinding, and unwinding. *Hobbs Mfg. Co., 313 Salisbury St., Worcester, Mass.*

Theses digest—Reference to theses completed by graduate students and to scientific and scholarly works published by the staff of Illinois Institute of Technology, including the college and graduate school, the Armour Research Foundation, and the Institute of Gas Technology are contained in "Publications from Illinois Institute of Technology." Abstracts of Ph.D. dissertations are given. Work dealing with plastics and



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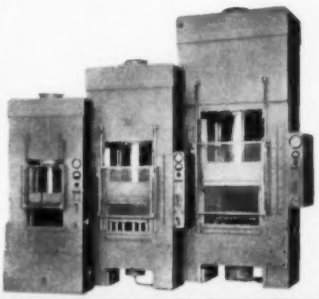

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***Long Ton: 2240 lbs.**

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chemistry is included. *Illinois Institute of Technology, Technology Center, Chicago 16, Ill.*

Esters, waxes—A line of fatty acid esters is presented in this catalog. Included are glyceryl esters, glycol esters, and polyethylene glycol esters. Specifications and properties are given. Suggested applications are indicated. A second catalog presents a line of synthetic waxes, giving uses for each. *Glyco Products Co., Inc., 26 Court St., Brooklyn 1, N. Y.*

Coater—Bulletin 1018 describes operation of the Multi-Coater, a coating, printing, and embossing unit said to do the work of seven different light-duty coaters plus that of a gravure printer and light-duty embosser. The machine is specially recommended in plants where space for drying facilities is limited, because it allows one oven to be used for a maximum number of processing operations. *John Waldron Corp., P. O. Box 791, New Brunswick, N. J.*

Polyester—Data sheets on a line of polyester resins for reinforced plastics applications are contained in indexed file folder. Chemical, physical, and mechanical properties as well as curing information are presented. *H. H. Robertson Co., Pittsburgh, Pa.*

Plastics tooling—"A Manual for Reinforced Plastics Tooling" is a technical guide that describes fabrication methods and indicates the uses of such plastic tools as spotting racks, checking and inspection fixtures, welding and assembly fixtures, duplicate die models, drill and trimming fixtures, and matrices, all made from thermosetting resins—phenolics, polyesters, and particularly epoxies—reinforced with glass fibers. The information presented is said to be based on actual operations in tool and die shops actively engaged in reinforced plastics tooling. The manual lists equipment needed for contact laminating. Types of available glass cloth weaves and characteristics of each, as well as properties of epoxy laminations, as established by laboratory tests, are also summarized. Step-by-step description of laminating and framing processes, and such procedural variations as bonding metal to plastic are presented. *The Marblette Corp., 37-21 30th St., Long Island City 1, N. Y.*

Styrene sheet—Four-page technical bulletin describes a high-impact polystyrene sheet now available in widths to 51 in., matte or high-gloss finish. The sheet can be custom-extruded in any length, up to 3/16 in. in thickness, with unlimited color possibilities. Physical and chemical properties of the rigid sheet are given. *Auburn Button Works, Inc., Auburn, N. Y.*

New resin—Suggested uses, methods of handling, and physical properties of Dapon, a solid prepolymer of diallyl phthalate, are presented in this six-page brochure. The compound is a free-flowing powder that is thermoplastic and soluble in low-molecular-weight ketones, benzene, etc. It is insoluble in alcohols, water, and petroleum solvents. If a peroxide catalyst is incorporated into the resin or its solution, it thermosets upon the application of heat and mild pressure to a finished product

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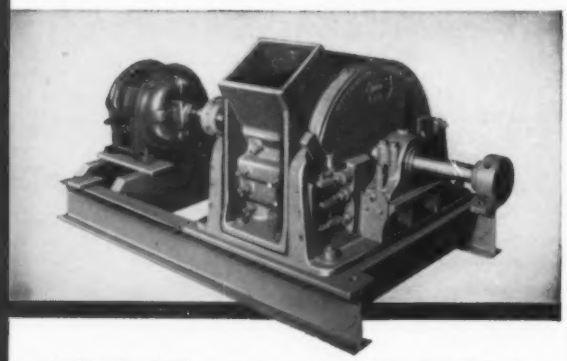

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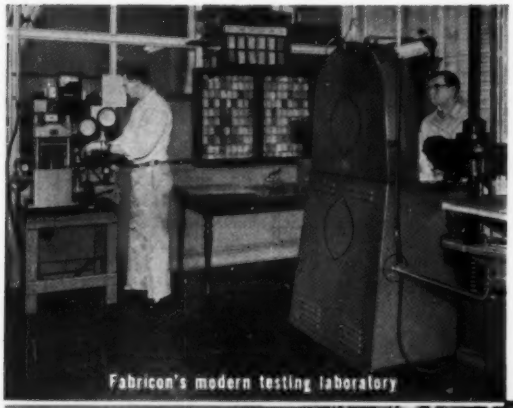

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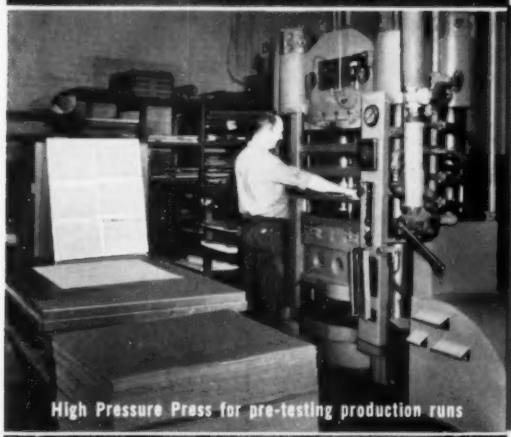
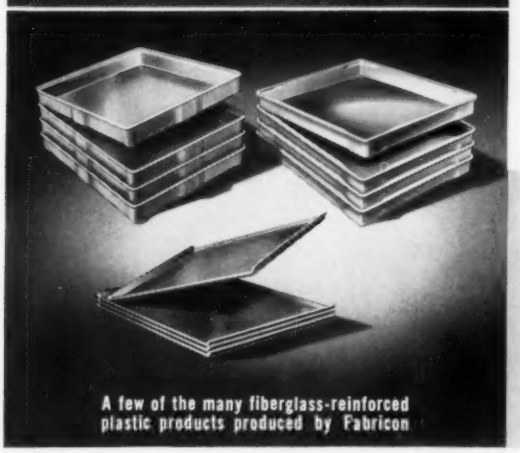


High Pressure Press for pre-testing production runs

One of several Fabricon impregnating ovens



A few of the many fiberglass-reinforced plastic products produced by Fabricon

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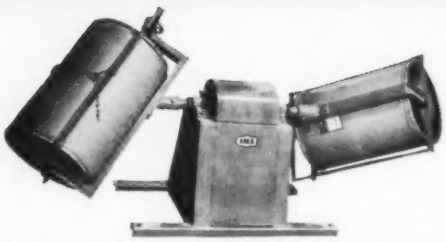

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which is no longer soluble. Some of the uses of Dapon are as follows: as a cross-linking agent for low-shrink polyesters, in the formulation of molding powders, in solutions for application to standard textiles (glass cloth, glass roving, or paper) for fabrication into a variety of products, and as a component in combination with other resins for various applications. *Ohio-Apex Div., Food Machinery & Chemical Corp., Nitro, W. Va.*

Reinforcements—Technical Bulletin T-55 describes three lines of asbestos-base reinforcing materials for use in the production of reinforced plastics articles. Information on physical properties of asbestos fibers, papers, and cloths; specifications, engineering and design data; fabricating techniques; test methods; and comparative properties of asbestos-reinforced laminates are included. *Raybestos-Manhattan, Inc., Asbestos Textile Div., Manheim, Pa.*

Reinforced plastics tank—Fuel tank made of a polyester resin reinforced with chopped glass roving is described in this eight-page brochure. Advantages claimed for the tank include corrosion resistance, low tooling costs, easy storage and field maintenance, and use of non-critical material. *Pastushin Aviation Corp., 5651 W. Century Blvd., Los Angeles 45, Calif.*

Protective tape—Four-page bulletin lists properties of a line of protective tape coatings, application information, and price data. The tapes are designed to provide protection against electrolytic, chemical, and atmospheric corrosion on pipes. *Plastic Engineering & Sales Corp., P. O. Box 1037, Fort Worth, Texas.*

Drill—Design information, specifications, and operating instructions for a 3-ft. arm, 7½-in. column radial drill, claimed to be the first such unit with a flame-hardened column, are contained in this literature folder. Information in installation, inspection, lubrication, and maintenance is included. *Cincinnati Lathe & Tool Co., Cincinnati 9, Ohio.*

Hydraulic standards—Up-to-date list of Joint Industry Conference (J.I.C.) Hydraulic Standards for Industrial Equipment is a 20-page unabridged listing that includes all revisions made at meetings of J.I.C. Also included are recommended practices on hydraulic packings and seals, examples of packing code identification, sample circuits using J.I.C. symbols, a glossary, and product information on a line of hydraulic equipment. *Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.*

Protective coatings—Bulletin 600 describes a series of modified phenolic protective coatings for use as tank lining, severe maintenance paint, and floor covering in acid, alkali, and solvent environments. The coatings are formulated in relation to specific end use; e. g. Phenoline 301 is for use as prime coat where the emphasis is on greater resistance to thermal shock, Phenoline 315 is recommended where resistance to nitric acid and chlorine is the prime consideration, etc. Application information is given. *Carboline Co., 331 Thornton Ave., St. Louis 19, Mo.*

Label—Uses of anodized, etched aluminum nameplates, designated Metal-Cals, for efficient trademarking, serial numbering, service labeling, catalog and parts numbering, and dial and gage marking are described in this booklet. Application notes and ordering information are included. Metal-Cals are backed by pressure-sensitive adhesive and adhere to any smooth, cohesive surface, including plastics. *C & H Supply Co., 415 E. Beach Ave., Inglewood, Calif.*

Thixotropic agents—Technical data sheet on Permagel, Attasorb, and Attasol, thickening, gelling, and suspending agents for organic or aqueous systems, presents properties of these three products and lists suggested applications and formulations. Equipment for dispersing them is also indicated. *Minerals & Chemicals Corp. of America, Metuchen, N. J.*

Research facilities—Brochure R-14 details organizational setup and facilities for basic, applied, and developmental research in servomechanisms, nuclear physics, upper air studies, weather reconnaissance, radar, countermeasures, sonar, guided missiles, airborne electronic

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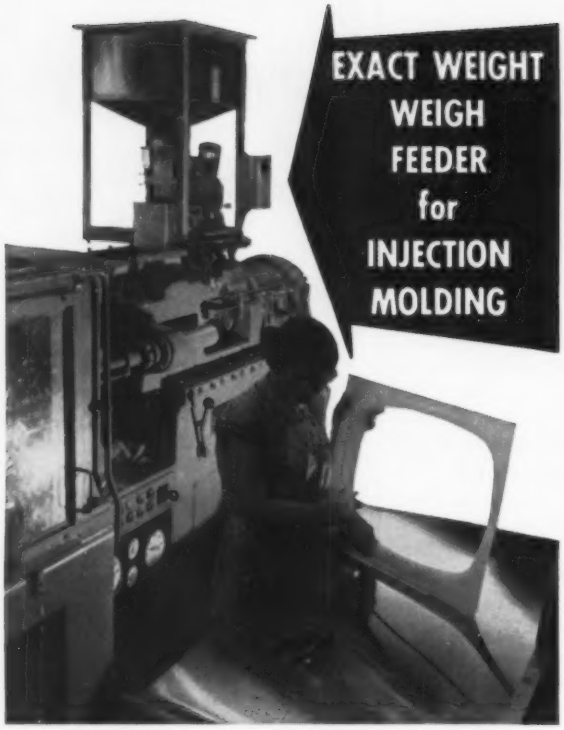

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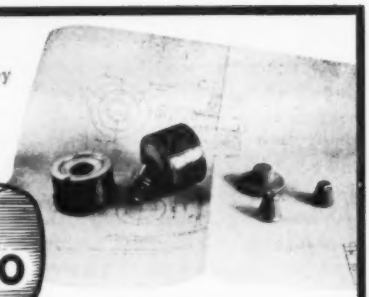

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instruments, airborne fire control systems, electronic instrumentation, human engineering, and general electro-mechanical developments. Included is a description of the types of work carried on by the various sections, as well as examples of research and development work on some of the unclassified projects. *Cook Research Laboratories, a Div. of Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.*

Colorants—Uses of paste colors with polyester resins are outlined in this series of literature sheets. Mixing information and price list are included. *Ferro Corp., 4150 E. 56th St., Cleveland 5, Ohio.*

Product catalog—Facilities and products of a manufacturer of O-rings and precision-molded parts for industrial, commercial, and aircraft use are described in a 24-page catalog. Listed in the catalog are standard sizes of various O-rings. Also described is a rubber-to-metal bonding process. The company's method for sealing O-rings in individual pouches to meet military requirements is illustrated. Engineering and design information in the catalog includes service recommendations, dimensional data for installation of O-rings, O-ring test reports, and characteristics of vinyl products. *Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif.*

Control equipment—Bulletin I-N-1, describing the proper applications and functions for a line of temperature and pressure controls, includes information on Model PC pressure pilot control available for pressures from 15 to 500 p.s.i.; and Model ESC temperature pilot control available for applications from —40 to 700° F. *Seely Instrument Co., Inc., Niagara Falls, N. Y.*

Product bulletin—Twelve-page bulletin describes more than 35 types and grades of Insurok laminated plastics and molded plastics. Two charts list grades of laminated Insurok by outstanding properties and sheet Insurok complying with N.E.M.A., Federal, and Military specifications. Typical applications using sheet, rods, and tubes, and suggested techniques for drilling, sawing, tapping, shearing, turning, punching, milling, planing, and

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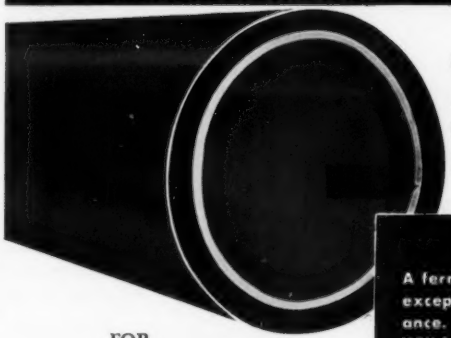

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  Eases the load of supervision. Large distant-view millivoltmeter Pyrometer Scales and Pilot Lights permit instant check on mold operating conditions. Cabinet (a) designed for location with other panel mounted Press Controls.
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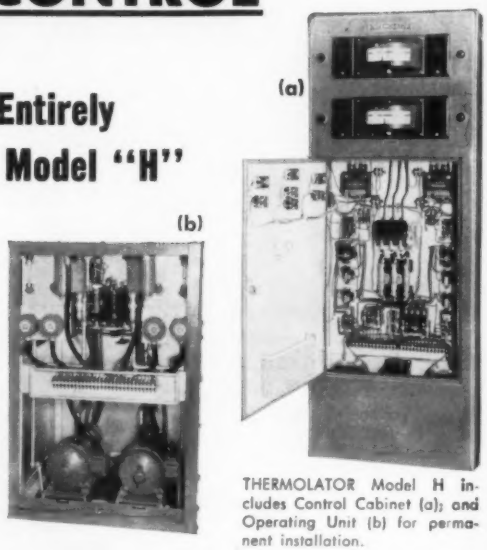
  One push button starts operation. After fast heat-up, large Wattage Auxiliary Heaters cut out for close control. Automatically adds or drains heat to maintain mold temperatures within ½° F. in range to 250° F.
- **Unequalled Mold Temperature Control Performance**
  Assured by High Velocity-High Capacity circulation, with exclusive patented control features.

(a)

(b)



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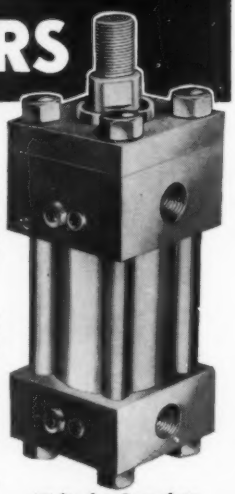

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shaping are included. A special section covers copper-clad Insurok laminates for printed electrical or electronic circuits and laminated Insurok for gears and bearings. *The Richardson Co., Lake & 26th Sts., Melrose Park, Ill.*

Metal detector—Bulletin 15B7217B describes an a-c electronic metal detector used to inspect plastics, food, confectionery, paper, rubber, and other non-metallic products for the presence of tramp metal. Principles of operation and construction details are included. *Allis-Chalmers Mfg. Co., 1163 S. 70th St., Milwaukee, Wis.*

Packaging suppliers guide—Pocket-size directories of custom and proprietary molders of polystyrene in the United States and Canada who serve the packaging industry are available to all buyers and designers of packages. Purpose of the booklets is to assist in selecting a package for a particular product. The alphabetical listings also briefly describe the services offered by the various companies. *Public Relations Dept., Koppers Co., Inc., Koppers Bldg., Pittsburgh 19, Pa.*

Thioglycollic acid—Physical properties and suggested industrial uses of a series of thioglycollic acid derivatives are presented in this six-page brochure. Some of the applications are as follows: gelling agent in vinyl chloride (amyl dithiodiglycollate); additives for high-pressure lubrication (esters of ethylene-bis-thioglycollic acid); condensation of thioglycollic acid with double bonds of non-saturated fatty acids (stearic acid-9-thioglycollic acid); etc. *Roussel Laboratories Ltd., 843 Harrow Rd., London N. W. 10, England.*

Formed Sheet Applications

Additional credits should have been given with three of the photographs published in connection with "Plastics Junior Giant," lead article in our April 1955 issue. The two photographs on p. 87 and the photograph in the right center of p. 97 were taken in the plant of Majestic Creations, Inc., Woodside, L. I. The editors regret that this fact was not so stated and it is our desire to call attention to the cooperation of Majestic in making these illustrations available.

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Production of

FOR the purpose of this report, production is the sum of the quantities of materials produced for consumption in the producing plant for transfer to other plants

PLASTICS AND SYNTHETIC RESIN PRODUCTION
From Statistics Compiled

Materials	
CELLULOSE PLASTICS:[a]	
Cellulose acetate and mixed ester	
Sheets, under 0.003 gage	
Sheets, 0.003 gage and over	
All other sheets, rods, tubes	
Molding, extrusion materials	
Nitrocellulose sheets, rods, tubes	
Other cellulose plastics	
PHENOLIC AND OTHER TAR-ACID RESINS:	
Molding materials[a]	
Bonding and adhesive resins for:	
Laminating (except plywood)	
Coated and bonded abrasives	
Friction materials (brake linings, clutch facings, etc.)	
Thermal insulation (fiber glass, rock wool)	
Plywood	
All other bonding and adhesive uses	
Protective-coating resins	
Resins for all other uses	
UREA AND MELAMINE RESINS:	
Textile-treating and textile-coating resins	
Paper-treating and paper-coating resins	
Bonding and adhesive resins for:	
Plywood	
All other bonding and adhesive uses, including laminating	
Protective-coating resins	
Resins for all other uses, including molding	
STYRENE RESINS:	
Molding materials[a]	
Protective-coating resins	
Resins for all other uses	
VINYL RESINS, total[b]	
Polyvinyl chloride and copolymer resins	
(50 percent or more polyvinyl chloride) for:	
Film (resin content)	
Sheeting (resin content)	
Molding and extrusion (resin content)	
Textile and paper treating and coating (resin content)[c]	
Flooring (resin content)	
Protective coatings (resin content)	
All other uses (resin content)	
All other vinyl resins for:	
Adhesives (resin content)	
All other uses (resin content)	
COUMARONE-INDENE AND PETROLEUM POLYMER RESINS	
MISCELLANEOUS:	
Molding materials[a,d]	
Protective-coating resins[e]	
Resins for all other uses[f]	

* Dry basis designated unless otherwise specified.
** Partially estimated. † Revised.
[a] Includes fillers, plasticizers, and extenders. [b] Production statistics by uses are not representative, as end use may not be known at the time of manufacture. Therefore, only statistics on total production are given. [c] Includes

Plastics Materials

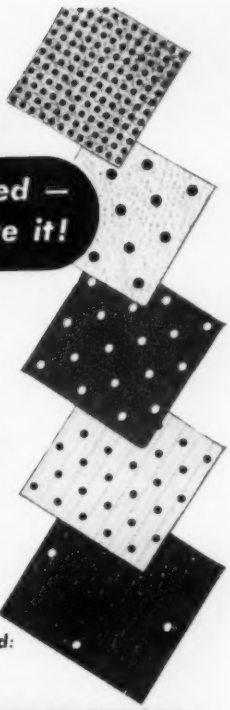
of the same company, and for sale. Sales include only the quantities involved in bona fide sales in which title passes to the purchaser.

IN POUNDS* FOR 1954 AND JANUARY 1955
by U. S. Tariff Commission

Preliminary total, 1954		*January***	
Production	*Sales*	*Production*	*Sales*
17,784,894	17,525,548	1,520,519	1,420,649
12,239,469	12,398,677	1,201,385	1,060,458
5,809,074	5,343,096	567,948	481,372
76,562,500	75,548,025	6,907,671	6,867,887
5,266,376	4,908,530	414,134	454,283
5,561,631	5,005,288	552,980	474,252
177,564,493	168,416,848	16,439,889	16,063,782
63,203,449	43,322,406	5,309,181	3,988,697
10,161,863	11,031,993	979,042	1,189,855
15,689,496	14,805,749	1,547,884	1,477,037
34,920,323	36,362,516	2,801,052	2,987,473
29,778,958	28,484,599	3,346,946	2,980,777
13,044,105	12,936,282	1,138,545	1,249,081
23,621,802	20,831,057	1,988,229	1,963,151
27,996,089	25,021,016	2,817,422	2,552,087
35,880,236	34,212,863	3,800,099	3,528,808
20,071,385	18,998,425	1,542,748	1,485,564
77,395,796	73,224,261	6,916,303	6,430,586
25,276,350	23,804,433	2,344,034	2,317,204
27,950,285	21,387,368	2,813,410	2,236,671
66,781,547	64,423,018	6,094,572	5,894,180
325,105,367	309,378,418	30,952,840	28,537,419
85,519,069	81,734,791	8,074,018	7,494,957
90,335,161	84,041,811	5,906,750	5,587,227
516,756,007	517,773,346	53,806,385	51,220,757
	69,942,539		6,290,815
	56,587,805		4,454,684
	147,284,047		15,441,360
	49,545,639		4,512,353
	34,889,532		4,340,504
	23,676,213		2,287,582
	35,147,920		3,600,105
	26,609,447		3,103,387
	74,090,204		7,189,967
202,894,474	203,146,166	18,323,510	18,404,461
203,921,698	173,846,696	22,870,752	17,545,816
6,848,623	3,688,546	384,888	221,038
125,480,799	133,255,185	13,147,007	15,593,635

data for spreader and calendering-type resins. [d] Includes data for acrylic, polyethylene, nylon, and other molding materials. [e] Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins. [f] Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.

Plastics Perforated



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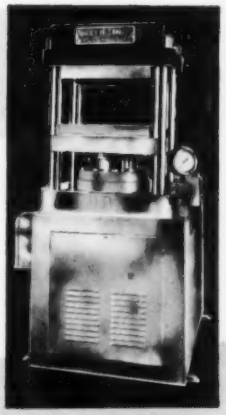

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Canadian S.P.I.

THE Thirteenth Annual Conference of The Society of the Plastics Industry (Canada), Inc., was held February 22nd and 23rd, 1955, at the Hotel London, London, Ontario.

The following papers were given:

Plastics in Building — L. A. Contini, Monsanto Chemical Co., Springfield, Mass.

Plastic Films — Dr. W. E. Henderson, Visking Corp., Chicago, Ill.

Mylar Polyester Film — J. C. Cawley, Du Pont of Canada Ltd., Montreal, Que.

The Foams: Present and Future — J. Carr, Dunlop Canada Ltd., Toronto, Ont.

Plastics in Automotive Engineering Programs — L. F. Bogart, The Marblette Corp., New York, N. Y.

Effects of Nuclear Radiation Upon Organic Materials — Dr. Samuel S. Jones, General Electric Co., Schenectady, N. Y.

Consideration of Injection Molding and Vacuum Forming Polystyrene — O. H. Yoxsimer, Westinghouse Electric Corp., Columbus, Ohio.

Potentials in Plastics — Hiram McCann, MODERN PLASTICS Magazine, New York, N. Y.

Fabrication of Chemical Plant From Rigid P.V.C. — G. Haim, Rediweld (Canada) Ltd., Montreal.

Reinforced Plastics in the Canadian Aircraft Industry — L. E. Balfour, Brunswick-Balke-Collender Co. of Canada, Ltd., Toronto, Ont.

Beta Ray Gauging — Dr. P. J. Stewart, Isotope Products Ltd., Oakville, Ont.

Sense and Nonsense — Prof. Marcus Long, Univ. of Toronto.

Development of Administrative Skills — Prof. Walter Thompson, Univ. of Western Ontario.

Copies of most of these papers, with the exception of the last two, may be had on request to the Secretary's Office, 159 Bay St., Toronto.

The officers elected at the Annual Meeting of the Canadian Section were: President, Frank G. Rice, Du Pont Co. of Canada Ltd., Montreal, Que.; Vice President, R. T. Todd, Irvington Varnish & Insulator Div., Hamilton, Ont.; Treasurer, R. W. Jackson, Canadian General-Tower Ltd., Galt, Ont.; and Councillor-at-Large, P. O. Jeffreys, Bakelite Div., Belleville, Ont.

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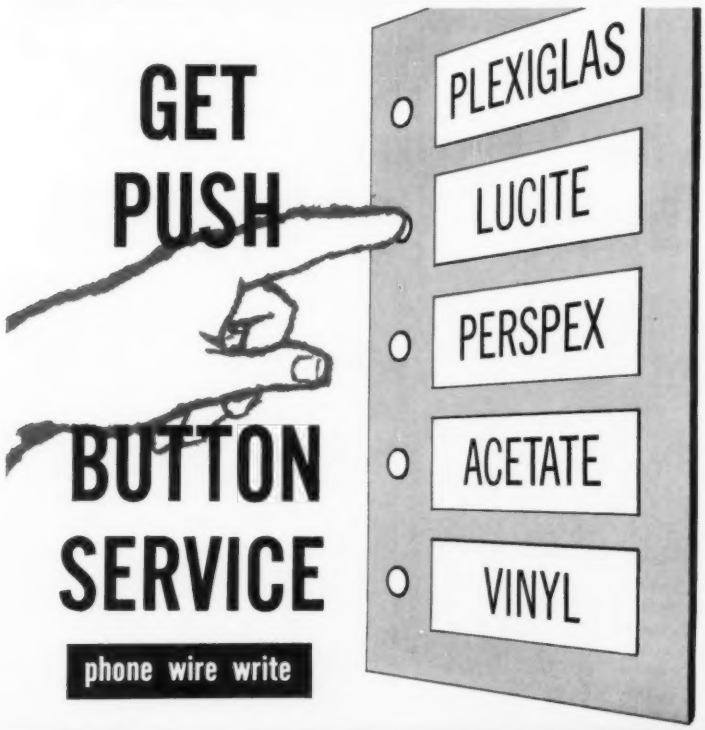

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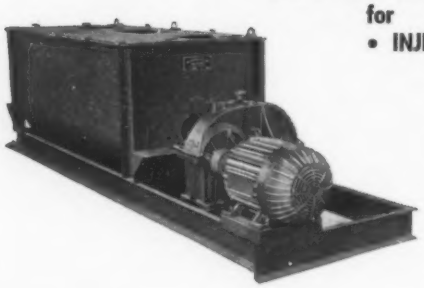

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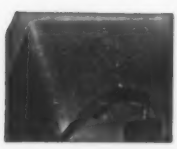

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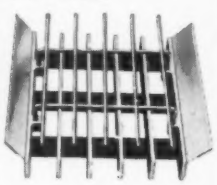

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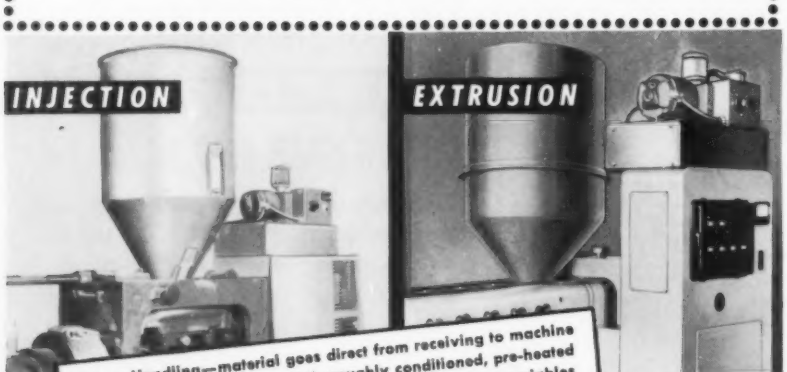

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Dialysis Bags

FLEXIBLE tubing of thin-gage polyethylene film plays a vital role in the dialysis work needed to produce Salk polio vaccine at the Cutter Laboratories, Berkeley, Calif.

According to laboratory officials, the polyethylene tubing has proved itself to be an ideal material for the dialysis bags used to remove chemical salts from the vaccine before it is tested. Although these chemical salts are actually present in amounts too small to be harmful to humans or animals, they must be removed

Clear polyethylene dialysis bags used in the production of polio vaccine

when the vaccine is tested on pure cultures of monkey kidney cells in order that the delicate balance of the cell culture will not be upset by these chemical salts.

After experimenting with several materials, the laboratory technicians selected polyethylene. One basic advantage of the polyethylene bags lies in their transparency. During production, technicians can visually check the vaccine contents through the clear walls of the bags.

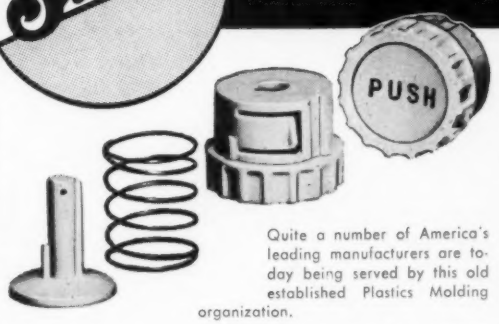
In addition, the film is tough enough to withstand the abuse of laboratory use without tearing and, because it is chemically inert, it is unaffected by any of the chemical solutions with which it might come in contact.

The vaccine is being produced at the Cutter Laboratories for use by the National Foundation for Infantile Paralysis.

CREDITS: Polyethylene film for the tubing is supplied by Visking Corp., Plastics Div., Terre Haute, Ind.

Sinko

CHOICE OF THE LEADERS



Quite a number of America's leading manufacturers are today being served by this old established Plastics Molding organization.

And typical of the many fine products Sinko makes for them is the Defroster Push Button Assembly (and its components) here pictured. This and other important items, including Vegetable Crispers, Butter Storage Units, Sterile Lamp Guards, Knobs, etc., are being fabricated for Admiral Refrigerators.

Sinko molds all thermoplastics, including Nylon; and has complete facilities for design and engineering, mold making, metal-plastic fabricating, 2 and 3 color spraying, hot stamping, and assembling.

WE OPERATE OUR OWN VACUUM DISTILLATION DEPARTMENT!

Sinko MANUFACTURING & TOOL CO.
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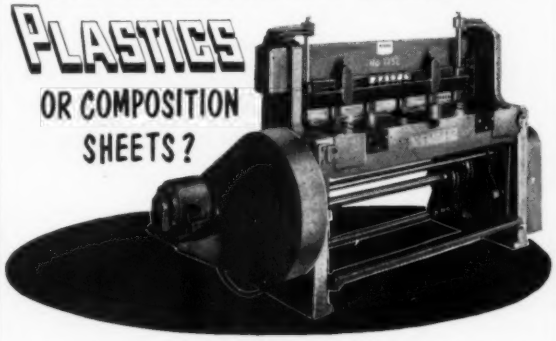

Wysong Squaring Shears . . . in power, air-power and foot-power models . . . have been successfully adapted for cutting various types of plastic and composition sheets.

Without cost or obligation, Wysong engineers will gladly test shear samples of the sheets you use and return sample cuts to you.

The use of squaring shears saves time and labor in most cases. Write for full information.

Cut Plastic Sheets With Squaring Shears

NATIONAL MACHINE TOOL BUILDERS ASSN. MEMBER

WYSONG

Wysong and Miles Company, Greensboro, N. C.

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solves another problem by WEATHER-PROOFING AUTOMOTIVE LIGHT SOCKETS

An automobile's light sockets are in a particularly vulnerable spot and for safety's sake must function reliably. Above all, dust and moisture must be kept out.

The answer was found in the use of **chem-o-sol,** a 100% solids liquid vinyl dipping and molding compound which was formulated to be applied economically on a continuous line production basis. This **chem-o-sol** is not only tough and flexible but has completely sealed the socket from moisture, dirt and chemicals.

Here is another example from our files showing how a product was improved through using **chem-o-sol.**

Chem-o-sols are available for many application methods. New products are constantly being developed and established products improved by spraying, molding, die-wiping and knife- or roller-coating this versatile basic material.

Our completely equipped laboratory and trained chemists stand ready to assist you in formulating the *exact* **chem-o-sol** to improve your product.

Dipped sockets are a product of Watts Electric and Manufacturing Company, Birmingham, Mich.

Write for Bulletin 141

Chemical Products CORPORATION
KING PHILIP ROAD • EAST PROVIDENCE R. I.

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Plastic flanges reinforced with L·O·F Garanized® Woven Roving Mat possess high wet strength, plus freedom from corrosion

Here's another dramatic illustration of the basic advantages offered by plastics reinforced with L·O·F Garanized roving. Mr. C. J. Larsen, superintendent of Basic Tool Engineering Company, Inc., of Los Angeles, California, says:

"We chose woven roving mat made of L·O·F Garanized roving, in the manufacture of this pipe flange, because of its superior wet-strength characteristics. This was most important to its underwater use in the new Los Angeles Water Works aeration plant."

You, too, can utilize the superior reinforcing properties of L·O·F roving in your product. L·O·F roving gives excellent results for preforming, for reinforcing mat or chopped strand. Even-tension packages for rod-stock applications offer the same superior reinforcing properties.

L·O·F roving imparts great flexural, compressive, and tensile strength to reinforced plastics; gives them high resistance to attack by moisture. And for the ultimate in strength, you can specify L·O·F Garan roving at no extra cost.

For technical data or information on standard packages and available sizes, contact our nearest office. Or write: L·O·F Glass Fibers Company, Dept. 15-45, 1810 Madison Ave., Toledo 1, Ohio.

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L·O·F GLASS FIBERS

L·O·F GLASS FIBERS COMPANY

TOLEDO 1, OHIO

Vinyl Pipe

PIPING fabricated from high-impact rigid vinyl is being used by The H. W. Madison Co., Medina, Ohio, to carry the corrosive vinegar and sugar-water used in the canning and processing of pickles and mayonnaise dressing. Expensive stainless steel fixtures were used prior to the installation of vinyl pipe and fittings.

During the manufacturing process, the piping is used to carry unfiltered vinegar through the various steps that transform it into 100 grain vinegar. As it travels through the pipes, the unfiltered vinegar is mixed with alcohol, bacteria food, and water and then filtered down through beechwood shavings containing bacteria.

According to plant officials, the vinyl pipe holds several advantages over the metal pipe formerly used; these include the following:

1) It is lower in cost.

2) It is easier to keep clean.

3) It can be threaded, cemented, and joined together right on the job for easier, more economical installation.

4) There is no scaling inside the pipe that can cause contamination or slow down the liquid flow by blocking the valves.

5) It resists vinegar and acetic acid corrosion, even when the liquid is heated to 150° F.

CREDITS: Vinyl pipe and fittings fabricated by The Colonial Plastics Mfg. Co., Cleveland, Ohio. Geon vinyl resin supplied by B. F. Goodrich Chemical Co.

Corrosion-resistant vinyl pipe carries vinegar in food processing plant

FOR PLASTISOLS that give "PLUS" QUALITIES

in Color Appeal and Service Life without a "Cost Premium"

Products Courtesy of Steere Enterprises, Inc. Akron, Ohio

STABELAN HR-50 . . .

This fluid paste stabilizer, specifically developed for Plastisol formulations, contains plasticizer in addition to cadmium and barium with synergized chelating agent. It is suggested for those desiring a single stabilizer that can be readily stirred into Plastisol formulations with minimum mixing and maximum dispersion . . .

Other **STABELANS** also available —

STABELAN E — Paste — For excellent heat and light stability, and long outdoor aging.

STABELAN HR — Paste — A "single package" stabilizer containing cadmium and barium components with synergized chelating agent.

STABELAN HR — Liquid — A synergized chelating agent.

STABELAN HR — Powder — Metal-bearing component of STABELAN HR Paste.

*STANTONE PC Colors . . .

Pigments flushed or dispersed in a plasticizer to produce a uniform easy working smooth paste. Extra fineness of pigment particle is developed to assure maximum tinting strength . . . Available in a complete line of colors — yellow, orange, red, blue, green, black and white, developed specifically for easy mixing in Plastisol formulations.

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POLYCIZER DBP— (Dibutyl Phthalate)
POLYCIZER 162— (Dioctyl Phthalate)
POLYCIZER 332— (Dioctyl Adipate)
POLYCIZER 532— (Octyl Decyl Adipate)
POLYCIZER 562— (Octyl Decyl Phthalate)
POLYCIZER 632— (Didecyl Adipate)
POLYCIZER 662— (Didecyl Phthalate)
* CELLUFLEX 179C— (Tricresyl Phosphate)
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* Registered U. S. Patent Office

STABELANS are manufactured by Stabelan Chemical Company

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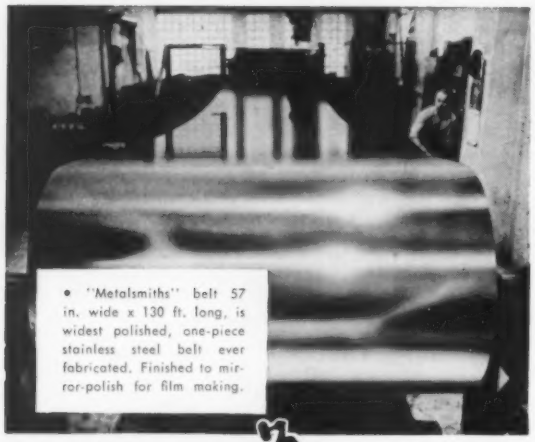
Endless Stainless Steel Belt PROCESSES AS IT CONVEYS!

- Produces automatic contact-gloss
- Improves setting
- Speeds cooling and conditioning



• "Metalsmiths" belt 57 in. wide x 130 ft. long, is widest polished, one-piece stainless steel belt ever fabricated. Finished to mirror-polish for film making.

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. . . The patented G. M. C. process of precious metal decoration on plastics

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Patented in U.S. and Canada

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No Connection with General Motors Corp.
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Friction Shoes

RUGGED friction shoes molded of a special phenolic material slide smoothly in the channels of aluminum windows to successfully replace fabricated shoes previously used for this application.

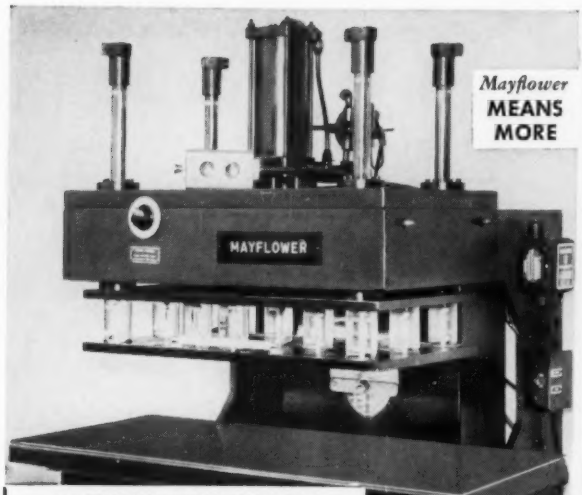
According to Michael Flynn Mfg. Co., manufacturers of the windows, the use of phenolic made possible a noticeable savings in cost over the material previously used. In addition, performance of the molded phenolic shoes is claimed to be better than that of the older parts. The shoes are molded of an impact-type material possessing anti-friction characteristics that are particularly adaptable to applications that require non-abrasive, smoothly moving parts.

The material's impact strength is also important, since the shoes, in sliding along the window channels, are subjected to constant stress. Originally, the shoes were molded in the same shape as the fabricated units. The method of inserting the shoes in the channel, however, put the parts under severe stress so that the shoes sometimes cracked during assembly operations, resulting in lost time and material.

To solve the problem, the piece was redesigned. The base of the friction shoe which receives most of the stress in assembly was made thicker and built up to the height of the rivet which holds it in place. This slight change in design completely eliminated the problem of breakage.

CREDITS: Shoes are molded by August C. Frank Co., Philadelphia, Pa., using phenolic supplied by Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y.

Non-abrasive friction shoes are designed for aluminum window channels



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Air-Operated—¼-ounce Capacity

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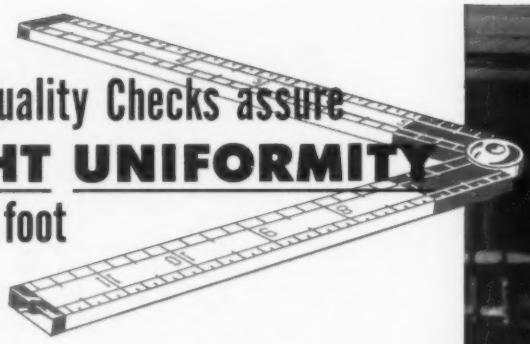

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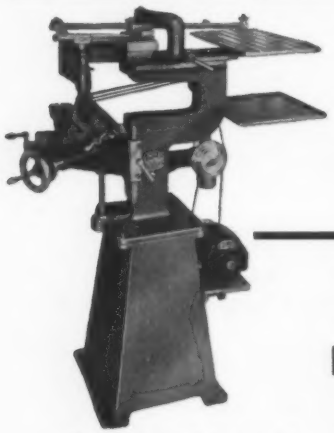

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Main Office and Factories Auburn, New York

Vinyl Liners for Home Swimming Pools

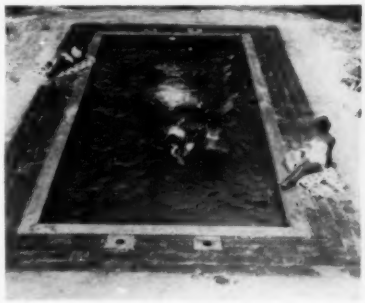
DESIGNED to simplify low-cost do-it-yourself or contractor installations of full-size home swimming pools, durable liners fabricated of vinyl are now available.

When rolled out on the loose earth floor of the pool and over the concrete-block side walls, the watertight liner eliminates many construction and maintenance costs. Washing the liner with soap and water is all that is necessary to keep it clean. The liner is also resistant to abrasion, cracking, or tearing and is unaffected by oils, greases, and water purifying chemicals such as chlorine.

For night swimming, the liner is provided with transparent vinyl windows permanently sealed into either end. During the evening hours, underwater lighting fixtures built into the concrete-block walls shine through the windows.

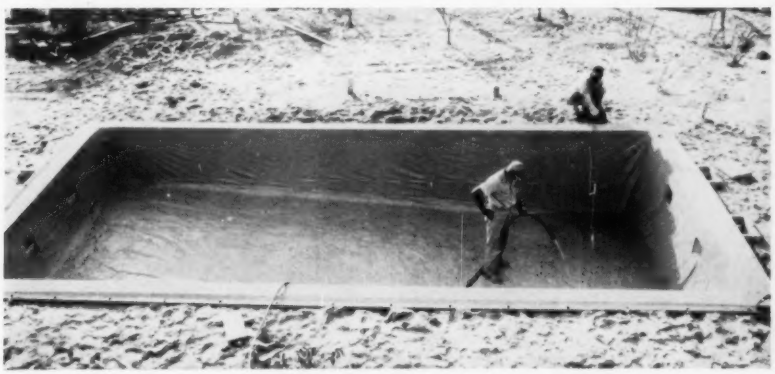
After the flexible liner has been rolled out along the floor and sidewalls of the pool, 2- by 10-in. boards are bolted to the top course of blocks to hold it in place. Standard plumbing drains may be used.

CREDITS: Liners are produced by Bilnor Corp., Brooklyn, N. Y., and distributed by Lin-O-Plast Corp., Brooklyn, N. Y.; Krene vinyl sheet is supplied by Bakelite Co.



Wood planks cut to conform to the sides of the pool hold liner in place

After excavating site for swimming pool and building concrete-block walls (above), vinyl liner is rolled into place to cover floor and walls. Pool is then filled (below)



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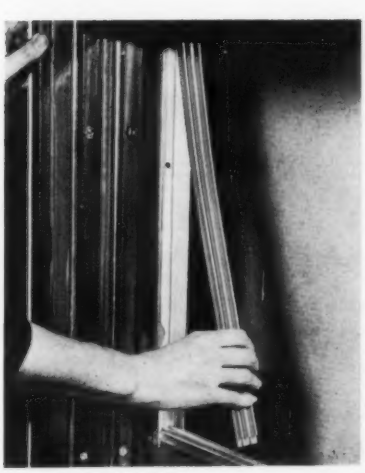
Window Tracks

EXTRUDED plastic tracks contribute much to the ease of operation of a combination storm-screen window that can be opened or closed without undue effort regardless of weather conditions.

Developed by Roberts S. Crane Associates, Columbus, Ohio, for use in windows manufactured by Weather-Seal, Inc., Barberton, Ohio, the tracks are extruded of tough, corrosion-resistant styrene copolymer into rigid, smooth-surfaced triple-grooved sections that fit into the window's metal frame. The window units slide up and down on these tracks without sticking or binding. Because the material is self-lubricating, there is no need for frequent oiling or greasing. The tracks are also flexible enough to compensate for expansion or contraction of metal window sections.

Several thousand windows using the new tracks have already been installed and home owners are reported to be highly pleased with their performance. In assembly, the track sections are permanently fastened to the upper half of the window frame. In the lower half of the window, however, the plastic track sections are simply snapped into place. This type of construction makes it easy to remove the lower track section when the storm sash has to be taken out for cleaning.

CREDITS: Kralastic styrene copolymer for the window tracks is supplied by Naugatuck Chemical Div., United States Rubber Co.



Styrene copolymer triple window tracks are easily installed in window frame

SUMP TYPE (cutaway)

When You Need A Filter—
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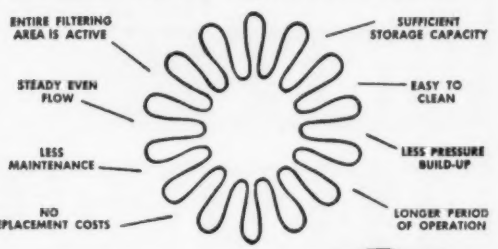
MARVEL'S
SYNCLINAL DESIGN
It's Balanced For Top Performance!

Look For These Important Features



For All Hydraulic and Other Low Pressure Liquid Systems

In the selection of a filter to obtain maximum efficiency and quality, the most important to consider is a specific type filter that will offer greatest ACTIVE filtering area with ample storage capacity for filtered out particles, rather than total filtering area alone. Over 550 Original Equipment Manufacturers install Marvel Synclinal Filters as Standard Equipment because they are designed to give this all-important balance for greater efficiency in filtration of liquids in all hydraulic and other low pressure circulating systems. Flow of liquids is maintained at a constant, steady rate of speed produced by the pump which brings about the desired effect of a gentle, evenly distributed accumulation of filtered out particles against the entire filtering surface with less restriction of flow. Result—longer periods of productive operation at minimum maintenance down-time. If this important balance is lacking due to efforts to cram too much filtering mesh for the sake of total rather than active area, filters soon become clogged causing pressure build-up, turbulent flow and in general decreases the efficiency of operating equipment. Depend on Marvel Synclinal Filters For All Your Filtration Requirements.

EASY MAINTENANCE

Both sump and line types may be easily disassembled, cleaned and reassembled by any workman, on the spot, in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation as described in catalog. Choice of monel mesh sizes range from coarse 30 to fine 200.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclinal design.

FILTERS FOR FIRE-RESISTANT HYDRAULIC FLUIDS

Marvel's most recent development is a filter for the efficient filtration of all types of fire-resistant hydraulic fluids.

IMMEDIATE DELIVERY!

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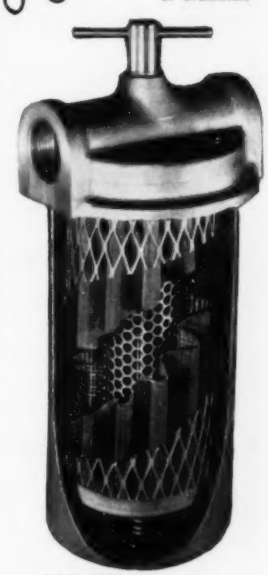

LINE TYPE (cutaway)

VISIT OUR EXHIBIT BOOTH #802
at the 6th National MATERIALS HANDLING EXPOSITION International Amphitheatre CHICAGO, ILLINOIS May 16-20, 1955

Catalogs containing complete data available on request

MARVEL ENGINEERING COMPANY
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MF-3

Without obligation, please send me complete data on Marvel Synclinal Filters, as indicated:

☐ Catalog #106—For Hydraulic Oils, Coolants and Lubricants
☐ Catalog #300—For WATER
☐ Data on filters for Fire-resistant hydraulic fluids.

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Illustrated: Comet Series PEX-TWIN, 36" x 48" molding area. Other sizes, 24" x 36" and larger . . . semi and fully automatic.

For complete information write Dept. MP-5

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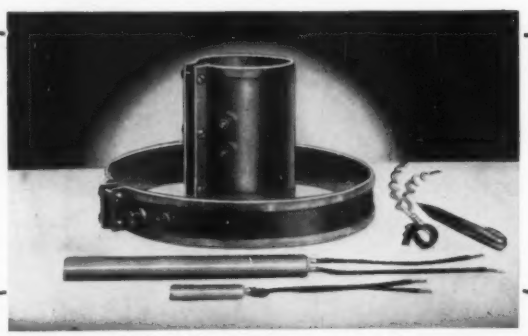

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Flexible polyethylene cover protects frayed and worn automobile arm rests

Arm Rest Cover

DESIGNED to fit over frayed or torn automobile arm rests, a molded flexible polyethylene cover has been devised that can be installed quickly and easily by the car owner without drilling or the use of special tools.

Molded entirely of polyethylene, the cover provides protection for the upholstered arm rest at the points where it receives the greatest amount of wear. The cover will not crack despite the abuse to which it is normally subjected; it will not stain; and it can easily be wiped clean of dust or dirt by simply using a damp cloth.

In addition to giving lasting protection where it is most needed, the smartly designed polyethylene cover adds trim beauty to the car interior. An attractive raised criss-cross effect that provides a comfortable nonslip surface on which the driver can rest his arm is molded into the top surface.

The cover is approximately 8 in. long, 3 in. wide, and about 2¾ in. deep. It comes in five fashionable colors—grey, green, brown, blue, and maroon—to match most car color schemes and is available in three different models designed to fit the arm rests of practically every type of car.

Mounting the cover is relatively simple. The two screws under the arm rest are simply loosened and the arm rest is pulled forward. The cover is then pressed into place over the frayed arm rest and the two screws are tightened to lock the cover in position.

CREDITS: The arm rest is molded and marketed by J. & S. Mfg. Co., Chicago, Ill.; polyethylene supplied by Eastman Chemical Co.

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NEW design concept in interior lighting makes use of translucent vinyl to create an inflatable lamp that hangs from the ceiling. A complete kit for constructing the lamp contains, in addition to the vinyl shade, a bulb fixture, suspension and light cords, and a small hook.

The bulb fixture in its wire frame is first fitted into the center hole of the doughnut-shaped flat lamp shade. The shade is then inflated to hold the fixture tightly in place. A suspension cord tied to the wire frame is next so attached to a hook screwed into the ceiling that pulling on either end of the cord lowers or raises the lamp.

Because of the light weight of the tough vinyl sheet, the complete lamp, measuring 20 in. in diameter, weighs less than 2 pounds. Pleasantly textured to help diffuse the light, the shade is easily cleaned.

CREDITS: Inflata-Lamps are made by Carradan Assoc., Chicago, Ill., using Krene vinyl supplied by Bakelite Co.

Vinyl shade can be inflated around bulb fixture (above) to make a lightweight "floating" lamp that hangs from cords attached to the ceiling

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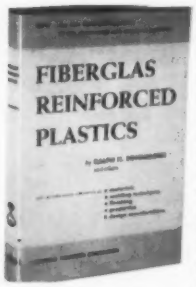

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Personnel Safety

(*From pp. 71-77*)

1.5% calcium, 1% phosphorus, and many other elements in smaller amounts. In effect it consists largely of water.

Of these elements, hydrogen and nitrogen are the most important components in the tissue-equivalent plastic. Therefore, a material containing 10% hydrogen and 3 to 4% nitrogen (the balance being carbon or carbon and oxygen) is needed. Preferably the material should be electrically conductive.

First attempts to make a plastic compound of this nature was by mixing powdered polyethylene, carbon, and ammonium nitrate in the desired proportions. After molding, it was found that the mixture was not quite homogeneous from the surface down and that the electrical conductivity was not always as high as desired.

Later Dr. Failla arranged with the Markite Co., New York, N. Y., to attempt to produce a small quantity of conducting tissue-equivalent plastic. Fair success was gained but, because of the manufacturing process used, the plastic had to be supplied in pieces and the necessary equipment constructed by fabrication. The electrical conductivity of this material was excellent.

Later, in the hope of developing a more satisfactory tissue-equivalent material, the Federal Telecommunication Laboratories undertook the work under contract with the Atomic Energy Commission. The new F.T.L. plastic was supplied in the form of granular molding compound. Surface conductivity of the parts molded from this material is satisfactory, but if any machining is done the conductivity is greatly reduced. Both the Markite and F.T.L. plastics adsorb and/or absorb gas to some extent; however, they are reasonably satisfactory for practical research purposes.

Safety Glass

Now taken for granted because of its wide use on automobiles, buses, trucks, and in many forms of industrial equipment, safety glass has quietly become a tremendous market for vinyl butyral film. Bonding this strong, flexible film between two sheets of glass produces an assembly that cannot be shattered and has very high impact strength. First used only in the windshields of cars, it is now standard equipment for windows as well and is used by all automobile manufacturers. About 2.7 lb. of vinyl butyral is used to make the safety glass for one car; total production of new cars was tabulated at 5,510,670 during 1954, pointing to a consumption of nearly 15 million lb. of vinyl butyral by this market alone.

Automotive uses account for some 90% of the total production of safety glass. The remainder goes into such applications as safety shields of many types, machine guards, burglar-proof windows, etc.

Designing for Safety

Prominent in the dissemination of information regarding safety and safety appliances, are the National Safety Council, a non-profit organization which does no manufacturing or testing but which investigates ways of making equipment and working conditions safer and promotes interest in safety in all walks of life, and the American Society of Safety Engineers with some 6000 active members.

With industry in general becoming more and more aware of the economics of safety equipment and of education of personnel in safety procedures and the use of safety devices, accidental injury and death rates in many areas are coming down percentage-wise. To cite just one example: At General Motors, where the value of safety engineering has long been recognized, accident frequency rate in 1954 was down 7% from 1953; accident severity rate (number of days lost through accidents per 1000 hr. worked) was improved 20 percent.

Much of the engineering of safety equipment and of the plastics applications that are becoming more and more indispensable in such engineering, is being done in-plant by management of a number of large and even small corporations. Standard equipment available from companies specializing in the manufacture of safety devices can be put to use to solve the majority of safety problems. But unique circumstances demand unique treatment . . . and safety engineers are looking to plastics for many of the answers they need.—END

Plastics Zippers

(*From pp. 78-79*)

for servicing, "zip-up" vinyl covers were installed.

Now, Miracle Adhesives Corp., New York, N. Y., has come up with a "zip-on" vinyl cover for insulation on ducts, pipes, and cables—especially those close to the ceiling or in other hard-to-reach places. The waterproof and chemical- and abrasion-resistant vinyl sheeting is simply wrapped around the insulation and the vinyl slide fastener is pulled shut. As an integral part of the cover, the fastener both holds the cover in place and completes the seal around the pipe. Thus installed at low labor cost, the protective covering permits ready access to the pipe, duct, or cable at any point without damaging the cover.

Among military uses of the plastics zippers, two applications stand out: 1) In the tail assembly of an airplane two molded vinyl pieces are wrapped in a vinyl "zip-up" protective cover. Unlike metal zippers, the vinyl closure does not interfere with radar transmission characteristics and eliminates the danger of sparks. 2) Geiger counters used in highly contaminated areas are protected by throw-away vinyl "zip-up" covers. Previously, after exposure to high intensity radiation, the counters had to go through an expensive decontamination procedure. When the vinyl covers become contaminated, however, they are simply unzipped, thrown away, and a new one put on.

In the garment field, FlexiGrip recommends their zippers be used only for applications where relatively short lengths are required, such as on pocket zippers for vinyl outerwear garments, vinyl baby pants fasteners, or closures for the front of vinyl overshoes.

Bathing suits that protect skin divers from exposure in cold waters is another fast growing market for the zippers. Other uses include: brief cases; eyeglass cases; phonograph record envelopes; inexpensive containers for documents; and a host of similar applications that boast the consumer-appealing description —"fabricated entirely of plastics right down to the toothless zipper."

CREDITS: Zippers are a product of FlexiGrip, Inc., New York, N. Y.; vinyl and polyethylene supplied by Bakelite Co.

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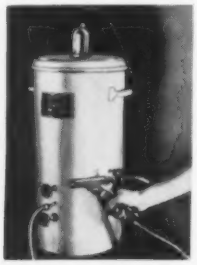

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DEPT. C-2

Electrical Parts

(*From pp. 82-85*)

0.001 to 0.003 and water absorption (48 hours at 50°C.) of from 0.11% for unfilled material to 0.7% for the high-impact type with a combination mineral and synthetic fiber filler.

The Blue Ribbon connectors previously mentioned were developed to perfect a connector incorporating wedging contact bands instead of conventional pin and socket contacts. The dielectric material used in them is a nylon-filled diallyl phthalate material.

In the Subminax RF connectors, available in both push-on and screw-on types and said to be the smallest ever offered for radio-frequency applications, Teflon is used as the dielectric. These connectors feature full-size electrical characteristics compressed into a space- and weight-saving design. Assembly is by means of crimping tools which make possible a fast, efficient operation. A vinyl boot, dilated and slipped over the assembly, draws up tight within a few minutes and provides a tight dielectric seal over the joint.

In some components which must operate under conditions of severe vibration, Amphenol makes use of epoxy resins which when cured become an integral part of the finished unit.

Printed Circuitry, Coaxial Cables

The rapid growth of printed circuitry in communications equipment and other fields has had an important impact on many electrical components. Printed circuit connectors are required for many such installations, as in certain types of radar equipment. One example of Amphenol's work in this field is a receptacle having 22 contacts to accommodate the printed circuit, with the etched circuit itself serving as the male contacts. Diallyl phthalate is used as the dielectric material.

In addition to the many types of specialized connectors and related components made by American Phenolic, the company is a leading producer of radio-frequency coaxial cables and transmission lines and miniature coaxial cables in which plastics are vital components.

The standard black vinyl jackets used on most of the company's co-

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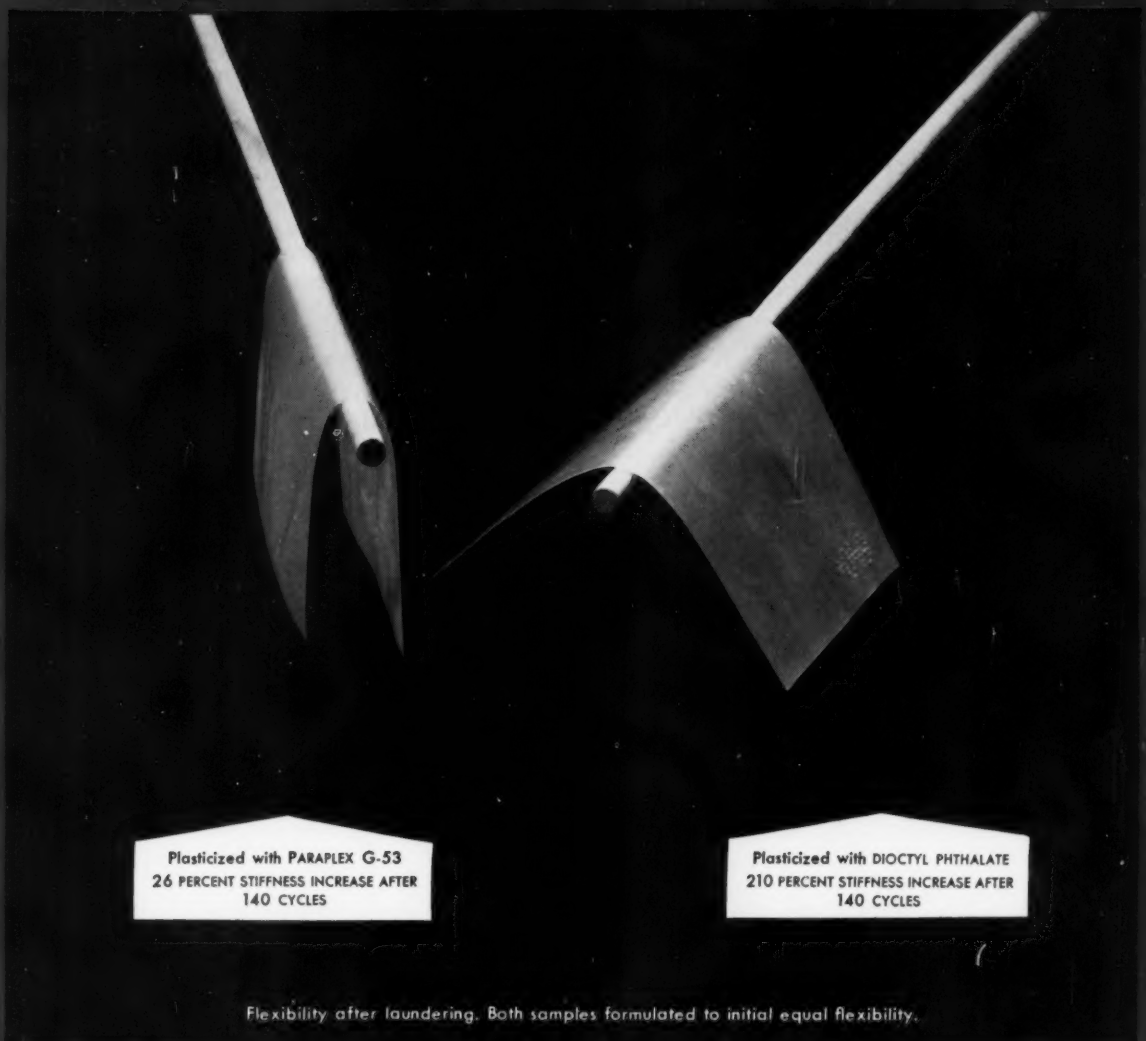

Flexibility after laundering. Both samples formulated to initial equal flexibility.

Watch out for plasticizers that wash out

Washing vinyl products like baby pants or hospital sheeting in hot, soapy water can be pretty tough on the vinyl plasticizer. Tough on an ordinary plasticizer, that is. PARAPLEX G-53 doesn't mind this kind of treatment. For example, samples of vinyl film containing PARAPLEX G-53 and samples containing dioctyl phthalate were laundered repeatedly in an automatic washer together with family wash. The films plasticized with PARAPLEX G-53 remained soft and supple; the others became hard and rigid.

This ability to stay put under actual washing conditions is just one feature of PARAPLEX G-53 polymeric plasticizer. When you add to that the plasticizer's resistance to extraction by aromatic and aliphatic solvents, you've got quite a combination. And what's more—PARAPLEX G-53 rebels against migration into lacquer, polystyrene, rubber, and baked finishes.

Ask for *What You Should Know about* PARAPLEX *and* MONOPLEX *Plasticizers*, a handy summary of properties and uses.

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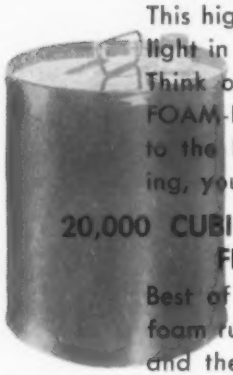

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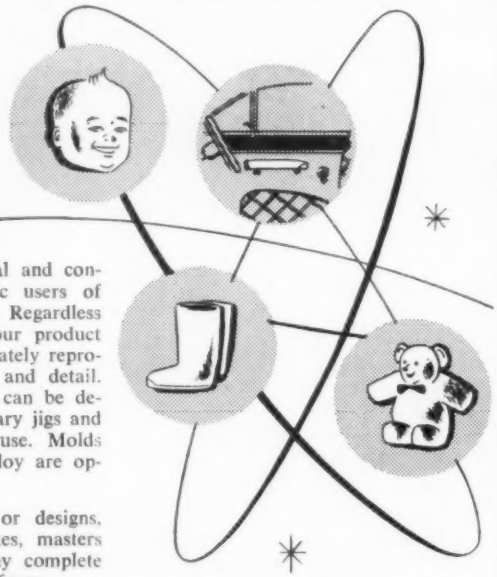

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axial cable has excellent abrasion and weathering properties and will withstand direct burial. Cable jacketed with standard black vinyl will withstand a —40°F. cold bend test and can also be used at temperatures as high as 180°F. This jacket contains an ester-type non-resinous plasticizer for flexibility. The standard gray vinyl jacket, also available on Amphenol coaxial cable, incorporates a resinous plasticizer which will not migrate from the vinyl into the polyethylene dielectric at elevated temperatures, as will the plasticizer in the standard black. A special low-temperature black vinyl jacket has also been developed, since the standard gray is usable only at temperatures down to —13° F. The special black jacket, also of the non-contaminating type, may be used at as low as —40°F.

Polyethylene cable jackets, which have replaced older-type cotton jackets, are used mainly for indoor applications. In order to obtain increased stability under ultra-violet light, the polyethylene material is pigmented dark brown. For high-temperature Teflon dielectric cables, a braided fibrous glass jacket is used, impregnated with high-temperature silicone varnish or, where chemical resistance is important, with Polyfluoron liquid dispersion to seal out moisture and keep it from fraying when cut. This jacket is suitable for use at up to 500°F.

High-Temperature Resistance

The advent of jet aircraft and guided missiles created a need for a dielectric material for low-loss coaxial cable having much higher temperature resistance. Also, the U. S. Navy had experienced certain difficulties with polyethylene cable runs in which the material was in close proximity to high-heat sources. Softening of the polyethylene dielectric resulted in a slight movement of the center conductor.

Teflon appeared to be the answer, but little was known about how to extrude this high-temperature plastic material. Through the development of specialized equipment, American Phenolic worked out methods for the successful extrusion of both Teflon cable covering and Teflon rods. The fluorine derivative, which has electrical properties equivalent to polyethylene and no measurable water absorption,

operates in a temperature range from —100 to 500°F. and is an outstanding dielectric.

Amphenol is reported to be the only producer of Teflon-covered cable by the screw extrusion process instead of the ram process. The equipment developed for this purpose is similar in operation to conventional extruders, but has a specially designed screw and uses temperatures as high as 1000° F. A baked-type Teflon (not lubricated) is used, and is normalized as part of the extrusion process. Both polyethylene- and Teflon-type cables are now available in numerous diameters and conductor arrangements. On r.f. transmission lines, the Teflon dielectric is covered with one or two silver-coated or plain copper shield braids and two wrappings of Teflon tape. The outer jacket, as mentioned earlier, consists of silicone-coated fibrous glass braid.

Controls

In the quality control laboratory, upon completion of every 5000 to 10,000 ft. of continuous cable, a 110-ft. sample is critically examined. After complete dimensional checks, the cable is tested for such quality factors as nominal impedance, velocity of propagation, attenuation at ultra-high frequencies, absence of cracks and fractures of dielectric and jacket after cold bend tests, etc.

In the aging ovens, a sample from each production run is held at 208.4° F. for 7½ hr. with specified weights on the center conductor; then the cable is inspected by fluoroscopic X-ray to determine heat deformation, and particularly to see whether the inner conductor has moved from dead center. The cold box mandril test subjects a sample of cable to a temperature of —40° F. for 20 hr. bent over a mandril ten times its outside diameter. If either the jacket or the dielectric cracks in this test, the entire run is rejected.

TV Transmission Lines

Twin-lead transmission lines for frequency modulation and television installations involve other specialized design and material problems. Amphenol produces several types of twin-leads to meet various conditions encountered in the field. The tubular twin-lead, for example, was specially developed for u.h.f. television work. The design of this cable

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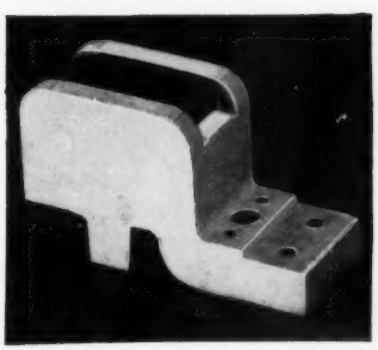

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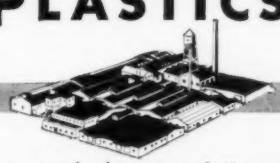

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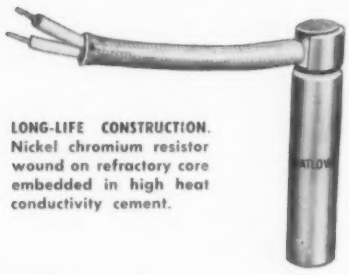

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WATLOW ELECTRIC MFG. CO. SINCE 1922—DESIGNERS AND MANUFACTURERS OF ELECTRIC HEATING UNITS

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is such that the concentrated field of energy is largely contained and protected by the tubular construction. Moisture, one of the greatest enemies of u.h.f. signal strength, does not materially affect the impedance or electrical efficiency of this type lead. Both this type and the flat type twin lead used for FM and v.h.f.-TV work make use of brown pigmented polyethylene as the dielectric. This material stays flexible at −70° F. and resists the effects of sun, chemical fumes, salt-laden and gas-polluted air.

Among the many other TV components produced are the Tele-Coupler, which facilitates connection of two or more TV receivers to a single antenna, and the Isonet, an isolating network which provides efficient coupling of separate u.h.f. and v.h.f. antennas to a single transmission line with minimum signal loss. The Tele-Coupler is mounted in a case molded of high-strength butyrate compound. Components and inside wiring are fully enclosed by the plastic housing, completely protected from rain, snow, or ice because the case has a skirt which extends below the terminal board. The smooth surface of the case sheds water and its sloping top prevents collection of moisture. The Isonet network housing is also molded of butyrate.

Back To Sockets

Among the many types of tube sockets now produced by Amphenol is the molded-in-plate type, in which a sturdy steel mounting plate is molded directly into a solid black phenolic body. The plate cannot vibrate or come loose. The sockets are available with either general-purpose or mica-filled phenolic as the dielectric material. They speed up production and reduce breakage losses because the steel mounting plate cannot be damaged during riveting processes in assembly.

Standing alone, the development of tube sockets from 1933 to 1955 could be an inspiration for research leading to even greater progress of plastics in electrical and electronic applications. And when such research is also directed into allied fields so that accumulated know-how can be put to productive use, as has been briefly sketched here, even greater emphasis is placed on the potentials of plastics.—END

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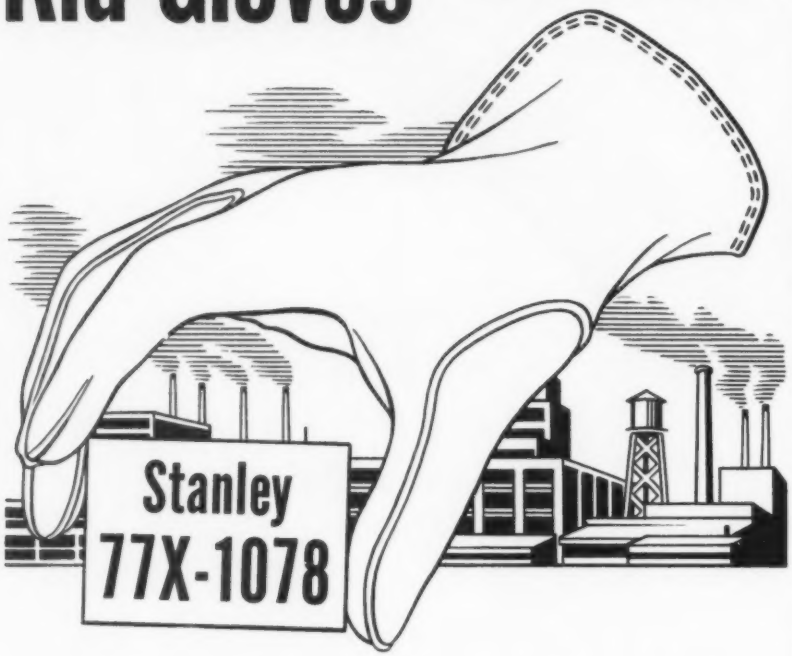

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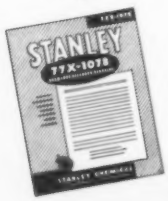

Write today for the new bulletin on 77X-1078 to the Stanley Chemical Company, 71 Berlin Street, East Berlin, Connecticut.

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STANLEY CHEMICAL

Chlorinator

(*From pp.* 90-92)

ing parts are involved. Other materials previously used for such applications had to be covered with lubricating grease. The corrosive chlorine gas would eventually combine with the grease to form a gummy, gelatinous mass which does not retain any lubricating or protective qualities. Thus, unless more grease was immediately applied, the metal parts would fail and would have to be replaced.

Vinyl Tubing

Also used in the chlorinator are a number of transparent vinyl tubes. These tubes carry a small flow of air or water and function as purge lines.

Where it is absolutely essential to use metal parts in the chlorinator, Fischer & Porter employ corrosion-resistant metals, such as silver, and silver-plated Hastelloy C.

In addition to reducing maintenance costs by eliminating expensive service calls, cutting down on the number of spare parts required to be held in stock, and eliminating the need for frequent cleanings, touch-ups, and adjustments, the use of plastics materials in the chlorinator share credit for the more efficient operation of the unit.

For many years, attempts had been made to adapt the spring-opposed diaphragm principle to the regulation of the chlorine gas entering and leaving the chlorinator. It was not until plastics materials were extensively used in the design of the Fischer & Porter chlorinator that it became economically feasible to adapt the principle without fear that the chlorine gas would destroy the parts essential to its successful operation.

CREDITS: Chlorinators are marketed by Fischer & Porter Co., Hatboro, Pa., which also fabricates the housing, using gel coat supplied by The Glidden Co., Cleveland, Ohio; polyester resin supplied by Pittsburgh Plate Glass Co., Pittsburgh, Pa.; and fibrous glass supplied by Owens-Corning Fiberglas Corp., New York, N. Y. Uscolite styrene copolymer supplied by United States Rubber Co., New York, N. Y.; Kel-F trifluorochloroethylene supplied by The M. W. Kellogg Co., Jersey City, N. J.; Teflon tetrafluoroethylene supplied by E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.; and Tygon vinyl supplied by U. S. Stoneware Co., Akron, Ohio.

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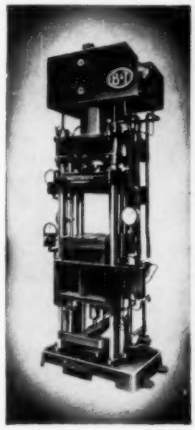

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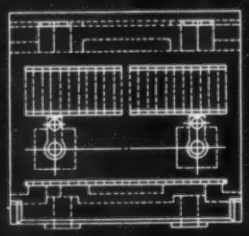

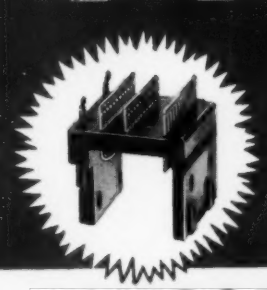

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SCRANTON 2, PENNA.

Color & Paint

(*From pp. 99-109*)

the limitation of this procedure is that the properties may differ even between two batches of the same average polymer size. One batch may be composed of polymer molecules of about equal size, whereas another may be a mixture of appreciably larger and appreciably smaller molecules. If a precise injection molding cycle has been established for a given batch of material to develop good parts, and this batch of plastic is followed by one that differs slightly, the cycle may be upset and inferior parts may follow. When parts are to be painted, they must be molded relatively strain-free or annealed after molding in order to remove the strain.

Orange Peel: Insufficient high-boiler in a paint formulation will allow a sprayed film to become immobile before it levels or flows out, thus giving a wavy or roughened surface called "orange peel." (See Fig. 6, p. 104.) The surface is unattractive and gloss will be reduced, especially if the waves are very small.

In silk screening, the silk marks must be allowed to level or flow together before the film gels in order to have a smooth continuous film.

Craters: Under certain conditions a paint film will rupture and pull away from small areas, leaving points, called "craters," almost void of paint. This phenomenon occurs generally when a spray paint is formulated with too much high-boiler, resulting in a low-viscosity, thin film being laid down on the surface. Such low-viscosity films may look perfectly uniform and smooth when sprayed on a clean surface. However, if the surface is slightly contaminated with oil, dust, or other foreign particles, or if the wet paint film is hit by a sprinkling of dust, craters may develop as in Fig. 7, p. 104.

Cobwebbing: Certain spray paints tend to string and agglomerate to give the appearance of a cobweb between the spray nozzle and the surface being painted. When such particles hit the surface, they tend to remain in lumps or are badly aerated, resulting in numerous bubbles which develop into craters or pinholes in the paint film.

In general, the answer to cobwebbing is to reduce the solids content of the system by the addition of sufficient thinner adjusted solvent-wise to keep the resin in solution and atomized between the spray nozzle and the surface being painted. Certain resins, however, cobweb so badly that paints prepared with them cannot be sprayed even at very low concentrations.

Plasticizer Migration: Plasticizers in such plastics as vinyl and acetate tends to migrate to the surface and may soften the paint film. Paints are available which will tolerate this, and it is important that they be used since softening can occur over a period of time, even after items have been shipped. An accelerated test can be made by placing a painted specimen of the plastic in a humidity cabinet for 72 hr. at 100° F. and 80% relative humidity. There should be no appreciable softening or loss of adhesion.

There are recurrent cases of adhesion failures in production, in-

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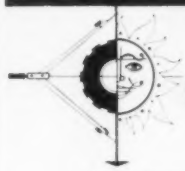

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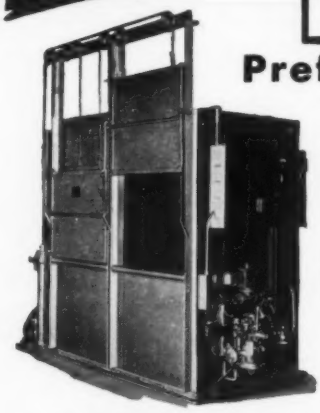

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volving paints which normally have good adhesion to the type plastic being painted. It is usually quite easy to locate and correct the trouble. Almost without exception such adhesion failures can be traced to one of the following: 1) humidity blush; 2) mold lubricants; 3) internal lubricants; 4) water in the air line, 5) oil in the air line; and 6) other contaminants.

Mold lubricants such as stearates and silicones should be used with extreme care if parts are to be painted. They are particularly incompatible with grease-resistant paint films and act as a barrier between such paint films and the plastic surface, with a resultant loss of adhesion. Paints with less grease resistance may be somewhat more compatible with mold lubricants and may be used when quality of the film can be sacrificed.

Small amounts of stearate can be removed by solvents inactive toward the plastic. However, silicones and excessive amount of stearate are most difficult to remove.

Many molding powders are formulated with internal lubricants to make them flow and handle better. These lubricants often appear on the surface of molded parts much like mold lubricants and have the same deleterious effect on paint adhesion. Small amounts of such lubricants can be removed from the plastic surface with solvents. Again, it is most difficult to get adhesion with grease-resistant paints if excessive lubricant is present.

In humid weather considerable moisture condenses in pressure tanks and collects in traps as the air is used. This water will eventually blow through the gun as droplets, causing humidity blush when the relative humidity at the time may actually be quite low.

In the same manner, oil may collect in the air lines and be blown through the system, giving an effect identical with mold release compounds. Filters are recommended since air traps are usually insufficient to remove water and oil from the lines. Once lines become contaminated, it is often necessary to clean them with a solvent, such as acetone, all the way back to the compressor.

Contamination can come from other sources. On one occasion a

(To page 213)

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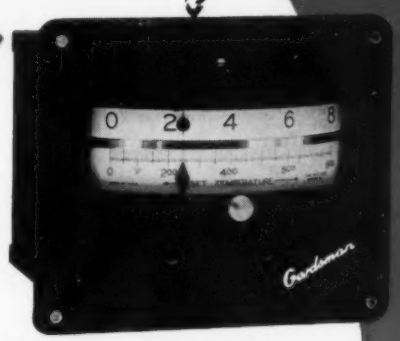

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DYES, CEMENTS, SOLVENTS. Thirteen page brochure describes line of dyes, dye concentrates, hot dip dyes, enamels, cleaners, solvents, and adhesives for plastics. Schwartz Chemical Co. Inc. (E-501)

HOT STAMPING MACHINE. Catalog describes machines for decorating plastics, leather, and paper, covering areas up to 1" x 3". Also presents details and prices of such accessories as dies, roll foil, type faces. Kingsley Stamping Machine Co. (E-502)

ELECTRICAL HEATING EQUIPMENT. Brochure describes firm's line of electrical heating equipment. Includes heating elements of the following types: cartridge, immersion, strip or conduction, band, radiant heat, and specially formed shapes. Industrial Heater Co. (E-503)

EXTRUDERS. Catalog describes company's line of extruders, available in sizes from 1¼" to 8". Also depicts auxiliary line of dies, take-ups, pelletizers, conveyors, pipe pull-offs, crossheads, pay-off stands, and capstans. Hartig Engine & Machine Co. (E-504)

VACUUM-DRAPE FORMER. Specification sheet and illustration of semi-automatic custom-made combination drape and vacuum forming machines. Complete construction details of machines are given. Price list is included. Zack Industries. (E-505)

ELECTRON TUBES. Condensed catalog, intended to serve as a quick reference guide in selecting electron tubes for high frequency heat sealing units and other electronic equipment. Catalog gives a summary of tube characteristics and application data for company's complete line. Amperex Electronic Corp. (E-506)

GLASS FIBER REINFORCEMENTS. Literature deals with various glass fiber reinforcing mats, surfacing and carrier mats, low density mats, bonded mats. Discusses theories of their use in reinforcing plastics. Modigliani Glass Fibers. (E-507)

PLASTICS WELDING. Details on pistol-like device for welding plastics through the use of high temperature gaseous heat without flame. Applicable for welding plastic sheet, spot heating, heat sealing, or for machine applications. D & R Plastic Welders, Inc. (E-508)

STABILIZER. Data on the specifications, physical properties, and solubility of "RS-31," a vinyl plasticizer which imparts excellent heat stability, clarity, heat sealing, and printing characteristics. Metal & Thermit Corp. (E-509)

POWER HAND FILE. Brochure describes the "Di-Profiler," electrically powered hand filing tool, which can be adjusted for reciprocating, rotating, or oscillating action. The tool is used for filing, honing, lapping, polishing, chafing, sawing, milling, grinding, or engraving of plastics and metals. Nord International Corp. (E-510)

LITHOPHONE PIGMENTS. Brochure and chart show line of eleven Cadmium Lithophone pigments available for use in manufacturing plastics colorants. Each color is broken down into three shades and property's chart gives specifications. The Harshaw Chemical Co. (E-511)

LAMINATING RESINS. Specifications of a line of phenolic-type resins formulated to meet special requirements in cloth and paper laminates for electrical resistance, mechanical strength, low water absorption, and decorative qualities. Synvar Corp. (E-512)

PREFORM OVEN. Literature discusses and illustrates with scale drawings, single and double compartment preform ovens used in the production of fiber reinforced plastics. The Lanly Co. (E-513)

SPRUE GRINDER. Literature describes sprue grinder featuring large cooling tray with anti-splash door, unrestricted throat, built-in throat clearance bar, and removable material catch pan. Specifications and prices included. Injection Molders Supply Co. (E-514)

HEAT-SEALING DIGEST. House organ contains articles on set-up problems involved in die and jig construction, on the principles of electronic heat sealing, on plasticizer migration from vinyl products. Kabar Manufacturing Corp. (E-515)

PLASTIC MOLDING EQUIPMENT. Catalog gives descriptions and specifications of the company's line of hydraulic, compression, and transfer presses, pumps, accumulators, and pelleting machines. Fully illustrated. Bradley & Turton, Ltd. (E-516)

PLASTICIZERS. Technical bulletin discusses properties and performance of company's line of citric acid esters as plasticizers for vinyls and cellulosics. Citric acid esters discussed are triethyl citrate, acetyle triethyl citrate, tributyl citrate, and acetyl tributyl citrate. Chas. Pfizer & Co. Inc. (E-517)

INFRARED LAMPS. Literature gives specifications and heating and drying characteristics of line of thirteen infrared radiant heaters. N. J. Thermex Co. Inc. (E-518)

POLYESTER RESINS. Handbook gives complete description of characteristics, specifications, and applications of the "Glidpol" line of polyester resins. The applications described include molding, laminating, casting, impregnating, and surface coating. The Glidden Co. (E-519)

INJECTION MOLDING PRESSES. Specification sheets contain detailed mechanical data and schematics of the company's line of 3, 6, and 8 ounce injection molding machines. Fellows Gear Shaper Co. (E-520)

STAMPING LEAF. Color chart contains 66 metallic and non-metallic color samples of stock. Most of the colors shown are made on glassine, acetate, and cellophane carriers, and in weights to suit various needs. Ralph W. Grauert, Inc. (E-521)

FOAMED VINYL PLASTISOL. Reprint from MODERN PLASTICS gives details of new gas-absorption plastisol foaming process, available on a license basis, that produces foamed vinyl plastisol by using inert gas instead of a chemically active foaming agent. Elastomer Chemical Corp. (E-522)

MODIFIED STYRENE SHEET. Literature describes high-gloss surface finish available on heat formable "Campco GM" impact styrene sheet. Actual and suggested end-use applications are depicted. Chicago Molded Products Corp. (E-523)

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REINFORCED PLASTIC LAMINATES. Forty-four page bulletin gives engineering and design information on felts, papers, and asbestos cloths for reinforced plastic laminates. Charts and tables provide test data, physical properties, and chemical composition of these materials. Raybestos-Manhattan, Inc. **(E-525)**

WEIGH-FEEDER. Literature describes "Pneumatron" weigh-feeder for injection molding machines. Explains pneumatic principle of operation that holds weight tolerances of ± .01 oz. Pneumatic Scale Corp. Ltd. **(E-526)**

GRANULATORS AND BLENDERS. Catalog contains photos and detailed descriptions of company's extensive line of pulverizing machines for use in blending, granulating, and milling operations. The pulverizer is made in five sizes, with motors from ¾ h.p. to 100 h.p. Pulva Corporation. **(E-527)**

CONTROL KNOBS AND HANDLES. Catalog shows extensive line of control knobs and handles available from stock molds. Includes detailed dimensions and specifications. Rogan Brothers. **(E-528)**

INJECTION MOLDING PRESSES. Multi-lingual literature contains illustrations and specifications of this company's line of injection molding machines. Models range in capacity from 1¼ ounces to 45⅝ ounces. A. Triulzi. **(E-529)**

GRINDER-MILLER AND POWER QUILL. Twelve page catalog describes line of hand-held finishing tools. Catalog also describes a complete line of accessories for these power tools. Precise Products Corp. **(E-530)**

ELECTRONIC PREHEATER. Literature lists specifications of model "8-B" preheater. This model has heatability of 12 ounces per minute. W. T. La Rose & Associates, Inc. **(E-531)**

SYNTHANE. Catalog gives complete details and specifications of "Synthane," a thermosetting, high pressure, laminated material, available in sheets, rods, and tubes, as well as molded-laminates and molded-macerates. Includes grades, specifications, properties, standards. Also describes company's custom fabricating and laminating services. Synthane Corporation. **(E-532)**

RADIANT HEATER. Literature describes radiant heater using infra-red long wave heat to produce temperatures up to 700°F, controllable within 5° limits. Features of equipment and performance data are given, together with a discussion of the use of radiant heat in vacuum forming operations. Radiant Heat, Inc. **(E-533)**

MOLDING AND DIE CASTING. Catalog, with prices, of standard mold bases and moldmakers' supplies, including ejector pins, reamers, grinding and polishing supplies. Also includes platen and mold design data on most injection molding presses. Detroit Mold Engineering Company. **(E-534)**

STEEL STAMPS AND DIES. 24 page catalog illustrates and describes a wide variety of steel stamps and dies for name and trademark identification. Includes photos of dies used by leading manufacturers for impression-stamping, ink-stamping, hot stamping. Sossner Steel Stamps. **(E-535)**

THERMOPLASTIC RESINS. Brochure lists line of 14 "Exon" vinyl and styrene resins, with suggested applications. Also describes manufacturer's research and technical facilities. Firestone Plastics Company. **(E-536)**

EXTRUSIONS. Booklet describes this custom extruder's facilities for compounding, designing, color matching, die making, and sample construction. Vogt Manufacturing Corp. **(E-537)**

COATING OF PLASTICS. Booklet gives details of "MIRRO-BRITE" metallized, printed, and coated cellulose acetate, polystyrene, butyrate, and mylar sheet stock, together with actual samples of 12 materials. Also suggests various applications for "MIRRO-BRITE" materials. Coating Products. **(E-538)**

FATTY CHEMICALS. Forty-one page handbook describes and gives specifications of "Hydrofol" line of fatty chemicals that include color dispersion agents, stabilizers, plasticizers, mold release agents, and coatings. Archer-Daniels-Midland Company. **(E-539)**

LOW TEMPERATURE EPOXY PLASTICIZER. Literature describes "Drapex 3.2" low-temperature epoxy plasticizer for vinyl chloride, polymers, and copolymers. Gives general physical properties, compares it with other plasticizers, and provides recommended formulations for specific applications. Argus Chemical Corporation. **(E-540)**

REINFORCED PLASTICS TOOLING. Illustrated manual shows equipment and materials needed to make reinforced plastics tooling. Describes all steps involved: selection of materials and resins, laminating and forming procedure. Also lists material suppliers. The Marblette Corp. **(E-541)**

EXPANSION FASTENERS. Sheet describes and gives specifications of "Neo-Grip" expansion fasteners which feature an expanding neoprene sleeve for secure, cushioned fastening in soft and brittle materials. Rocket Devices Corp. **(E-542)**

COLORANTS FOR POLYESTER RESINS. Technical bulletin gives specifications and prices of a line of iron oxide colorants used to produce opaque, translucent, and transparent colors in polyester resin products. Reichard-Coulston, Inc. **(E-543)**

STEAM BOILERS. Literature gives complete description and specifications of gas fired automatic steam boilers. Plastic industry applications are in compression, extrusion, and ejection molding. Mears-Kane-Ofeldt, Inc. **(E-544)**

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customer had adhesion failure which appeared due to an oily contaminant on the part. However, a thorough investigation indicated that no lubricant was used in the plant and there appeared to be nothing wrong with the molding powder. The air lines were clean. On the second day of rejected parts, an air fan, considerably above the spray booth, was found to be leaking oil which was fanned down on the parts as they were stacked by the booth prior to painting. This was corrected and there was no further difficulty. In another case, there was sufficient silicone in the air, coming from another press, to cause adhesion failure on parts where no silicone mold release compound was being used.

Tape Test

When a paint has been approved for use on a particular job, it is presumed that the paint meets the quality requirements and that it will be uniform. However, production must be checked daily to see that good parts are being produced. A close visual inspection of parts and a spot check for adhesion, after paint is thoroughly dry, will catch practically any problem that can arise in a paint operation. Transparent "Scotch" cellophane tape #600 and masking tape #202 have about the same adhesion value and are being accepted as standard for checking adhesion. (See Fig. 8, p. 109.) Both types of tape are available from the Minnesota Mining and Manufacturing Co.

Viscosity: Viscosity can be controlled quite accurately. However, this becomes increasingly difficult when paints must be made in small quantities. Consequently, solids content and pigment-to-resin ratio are held constant and viscosity is held within reasonable limits.

Viscosity is an important property of paint but must be understood to avoid confusion when considering other properties such as speed of coverage and mileage of the paint. To illustrate this point, a spray formulation of low viscosity will be compared with a spray formula containing exactly the same solids but at a very high viscosity.

If the low-viscosity material with X% solids is sprayed without thinner, the solids content will increase as solvent is evaporated between the spray nozzle and the surface and the solids content of the wet film will be $(X + Y)\%$.

If the high-viscosity material with X% solids is thinned 1 to 1 (by weight), to reduce it to the same spray viscosity as the preceding sample, the solids content becomes $\frac{1}{2}X\%$. Now, in order to get a wet film of the same thickness with the same $(X + Y)\%$ solids it will be necessary to blow away all of the extra thinner ($\frac{1}{2}$ of the thinned paint by weight) plus the same amount of solvent that was blown away in the previous example.

In practice it is difficult to get rid of the extra solvent without slowing down the operation appreciably. The tendency is to blow away less than the indicated amount of solvent, resulting in a film with much less than $(X + Y)\%$ solids. The dry film will be thin and will not cover well. Accordingly, low-viscosity materials can be sprayed at higher solids and will give better coverage with fewer passes of the spray gun. Thinner used in reducing paint adds nothing

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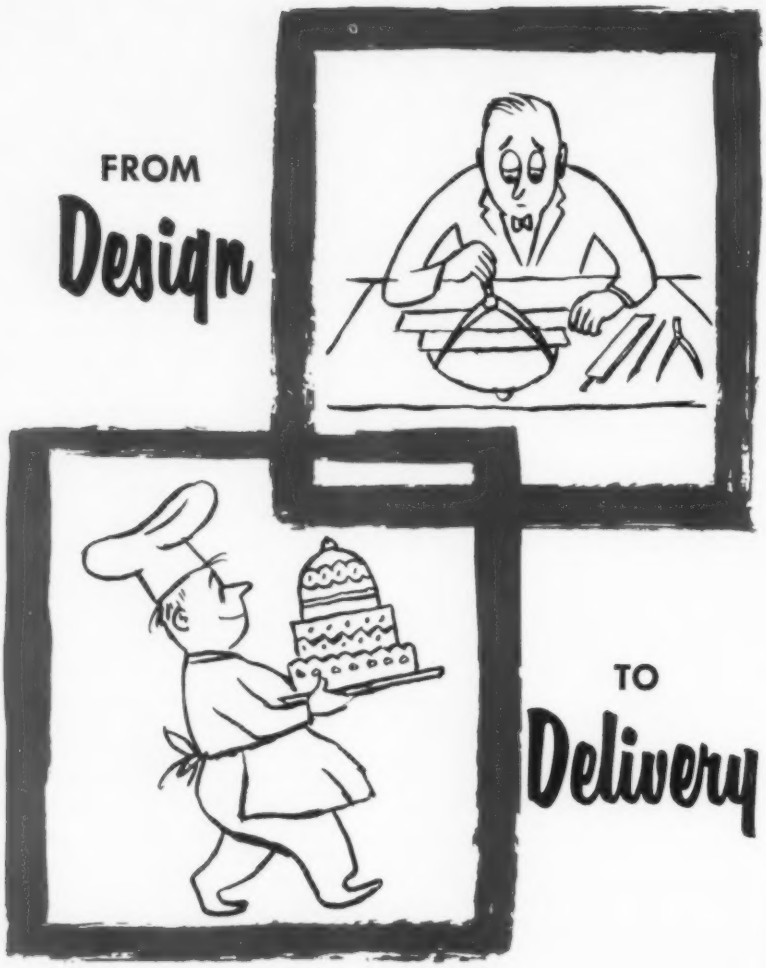

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to the covering power, but does add to the cost.

Coverage: Very often, a particular opaque color is needed which is virtually impossible to obtain. For example, there are transparent colors which are clean and which have a particular shade when transparent. These colors, however, do not have coverage. Iron blue is quite transparent and has a particular color, and anything done to iron blue to give it opacity beyond building film thickness changes the color. Very often, in reverse side application, the best answer is to apply the transparent color and then back it up with a selected opaque color.

Pigment-to-resin ratio is important in maintaining gloss and general film quality. Consequently, it is often impossible to add more pigment for better coverage. Increasing the solids also increases the viscosity that must in turn be reduced before spraying.

Metallizing

Metallizing is a specialized form of decorative coating involving the use of several different types of paints. A system for metallizing the second surface of clear plastic usually includes an undercoat which serves to smooth out any imperfections on the plastic, thus making possible a brighter plate. It may be used as a clear to give a silver appearance when plated or may be tinted with transparent colors to give gold, blue, green, red, and various other brilliant colors. The ideal undercoat has adhesion to the plastic surface, does not etch the plastic surface, and is a material to which the deposited metal has adhesion. There are many ways of applying the metal plate, but this discussion will be limited to vacuum metallizing with aluminum.

The undercoat must be thoroughly cured if it contains a curing type resin, and must be completely free of solvent and moisture before parts are placed in the vacuum chamber. Baking is recommended to remove traces of solvent even when lacquers are used. In addition, undercoats should be formulated with resins which have low vapor pressures and it should be remembered that volatile plasticizers are objectionable. The presence of volatiles in an undercoat increases the time for evacuation of the chamber for firing.

The vacuum plate must be pro-

tected against chipping, scuffing, and corrosion. Opaque back-up coats are used in second-surface work on clear plastics since the deposit of aluminum is usually thin and otherwise may transmit light. The solvent system of the back-up coat must in no way attack the resin system of the undercoat since such attack disrupts the appearance of the plate. The back-up coat must have adhesion to the system and must be of sufficient quality to meet the general requirements of the job. It should have good abrasion and scuff resistance, and for many applications it must have grease and humidity resistance.

For surface work, an undercoat is often used to smooth out surface imperfections and is usually applied by dipping since many objects employing this type of finish are classified as novelties and trinkets. A topcoat of clear is then added to give the object a silver appearance. The finished part may then be dyed by a simple dip operation.

Very often plastic objects are plated directly with no under coat and the back-up coat or top-coat must be adjusted to the properties of the plastic.

Summary

Many problems are involved in painting plastics and no paint meets every possible requirement. Compromises must be made. The best one can do is formulate for as many good points as possible and adjust for shortcoming as they arise. Consequently, a paint which works satisfactorily one day, on one given piece of plastic, under a given set of conditions, may work differently the next day if any one of the following conditions are changed: relative humidity, amount of mold lubricant used, amount of internal lubricant present, amount of dust in the spray area, or condition of the spray equipment.

It is, therefore, most important to study the conditions and the end product continually in order to assure the production of good parts. In short, quality control of parts coming from the spray room is necessary as a check against trouble on the production line and against the shipment of materials that are off-quality. A visual check and a spot check for adhesion will catch most off-quality paint jobs.—END

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Heating Cylinder

(*From pp.* 110-120)

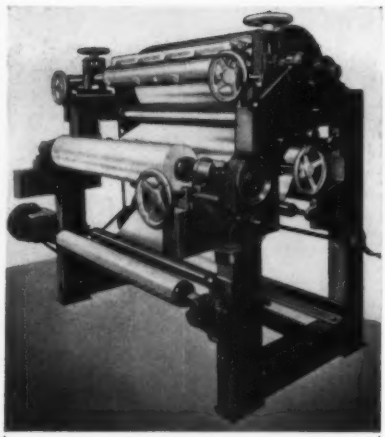
seem to show that lowering the front heater has the greatest effect on the plastic temperature. Since the front heater supplies most of the heat to the torpedo as well as to its section of the outer cylinder, these results are reasonable to expect.

From the work thus far reported, it can be concluded that not much is to be gained by lowering the setting of one of the heaters by a small amount. If all of the heaters are kept at one setting, less work would be put on each individual heater. There may, however, be a particular molding job where small changes in heater setting may mean the difference between good and unsatisfactory molded pieces.

It should also be noted that as each heater was lowered the other two heaters remained on all of the time. This would give a good indication that not enough heat was available to this particular cylinder. Accordingly, another heating cylinder of similar design but double the size and with eight times as much heat available, was used. The same experiments were repeated and, over a comparable range of settings, a smaller drop in plastic temperature was noted and the drop was constant for all changes in the three heater settings. Thus, with this larger cylinder, the two zones of the cylinder which remained at the set control temperature had enough extra heat available to supply some to the zone whose temperature was reduced.

Machine Efficiency

The term "machine efficiency" should not be confused with the heating efficiency ratio $\frac{T_s - T_o}{T_i - T_o}$ previously described. Machine efficiency is defined as the ratio of the amount of B.t.u./hr. acquired by the plastic to the amount of B.t.u./hr. supplied electrically to the heaters. To determine this machine efficiency, the plastic temperature was measured in the same manner as before, and the heater energy was determined by attaching timers to the heaters and measuring the length of time each heater was running. When this time is multiplied by the wattage of each heater, the answer can easily



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be converted into B.t.u./hr. of energy input to the machine.

The first experiment with the bigger machine was made by operating at 45 lb./hr. and varying the front heater from 400 to 513° F. The rear and center heaters were held at 513° F. Results are listed in Table IV, p. 120.

With the front heater setting lowered, the center heater carried more load and furnished some heat to the front zone. As the front heater was raised in temperature, it began absorbing more of its normal load and the center heater load decreased. The machine efficiency and the plastic temperature remained relatively constant. The total heat lost into the air and the frame of the machine is about 6700 B.t.u. per hour.

Table V shows the results of another test run with a constant control temperature of 515° F. at various plasticizing rates. Here it is evident that the machine efficiency increases linearly with higher production rates. The heating efficiency decreases with production rate as has been shown previously.[1] The table also shows that as the production rate increases, the loads on the individual heaters shift. At the higher production rates the load on the center heater increases rapidly, while the load on the front and rear heater does not change much. Table VI shows the same effect at a higher control temperature of 615° F.

By operating the molding machine at high rates, the efficiency of the heaters is greatly increased. The energy demanded by the rear heater remains relatively constant while that of the front and center increases. This indicates that more heat is needed in the forward end of the cylinder at higher production rates.

From the above results, it can also be seen that heat loss, whether it be into the air, machine frame, or cooling water, is quite high. An attempt was made to determine a method of reducing the radiation into the air surrounding the heating cylinder. Several types of shields were tested and the results listed in Table VII. The tests were run at a plasticizing rate of 54 lb./hr. at a control temperature of 515° F.

(Part 3 will appear next month.)

[1]Beyer, C. E., and Dahl, R. B., "Measurement of Heating Capacities of Injection Molding Machines," Modern Plastics *30*, 124, Sept. 1952.

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Sorption of Water

(*From pp.* 138-148)

chain network is expanded as compared to its normal arrangement below glass temperature. This allows the water molecules to permeate more easily between the polymer chains and a larger quantity of water is retained. Swelling accompanying the retention should result in an increase in the number of sites for the attachment of water molecules. Steady state conditions are not fixed but change due to the continuous swelling process. Water sorption equilibrium above T_g, if at all obtainable, will be reached only after many years exposure.

The larger water sorption and diffusion rate of low-molecular-weight specimens, especially above T_g, may be caused by increased solubility of water in the polymer. The larger internal surface of the low molecular weight polymer will result in an increase in the number of possible water-reactive sites within the structure. The probability of attachment of water molecules between ends of polymer chains is thereby increased. Some form of structural discontinuity is also more likely to be encountered. Thus, if capillary condensation is involved in the sorption process, a higher water sorption value will be obtained. The amount of liquid sorbed may also be affected by molecular weight distribution.

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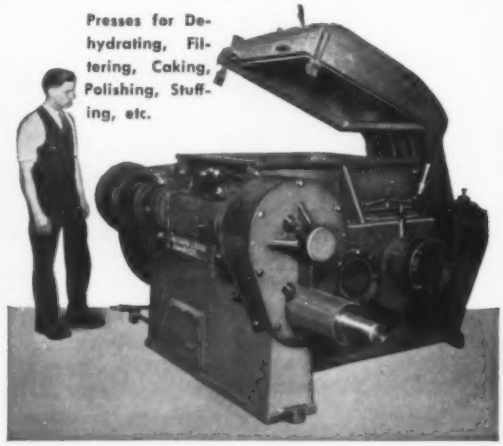

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THE PLASTISCOPE*

NEWS AND INTERPRETATIONS OF THE NEWS

By R. L. Van Boskirk

Vinyl Boom Raises Questions

HIGH rate of sales of vinyl chloride resin has been an outstanding feature of the plastics industry for the past five months. Largest gains have been in wire coatings, floor coverings, and coated fabrics. All other categories have also shown increases but not in such spectacular fashion. Although the industry has accepted this increase with pleasure and satisfaction, there is a cautious undertone prevalent which is based on suspicion that sales have been inflated beyond normal demand.

The reasons for this suspicion are as follows: The tremendous demand for wire coating materials has been based on the wire manufacturers' fear that copper prices were going to zoom upward due to shortages, strikes, and various international situations. The wire coaters have been buying resin, dry blends, and compound like mad; in fact, they have been buying almost anything they could get. Scarcely anyone believes they are moving finished wire into the trade as fast as they are coating it, even though the market for automotive and building wire has been extremely good. The wire coating industry has a reputation for working on a "feast or famine" basis, and after a luscious "feast" period such as this late one has been, a "famine" period can be mighty disastrous to those who sell materials for electrical wire.

Furthermore, there is no indication that the market for vinyl-coated wire can be appreciably extended unless the Armed Services suddenly start ordering in large quantity again. Basic uses as low-voltage wire in automobiles where there is sometimes as much per unit as 300 ft., (which would require more than ½ lb. of solid resin), and in building or house wiring probably won't expand into other applications until a higher-heat-resistant resin is developed. In addition, other materials are challenging vinyl for its present job. But as long as automobiles are being built at an 8-million per year rate, new houses at a 1.2 million to 1.4 million rate, and the possibility of rewiring thousands of old houses exists, there is apparently a market for somewhere between 70 and 100 million lb. of resin for wire. That's a lot of resin, but such consumption must depend upon at least maintaining the present high production level in the automotive and construction industries.

The vinyl-coated fabric industry shot upward last fall when the automotive industry not only began its heavy production rate, but increased the average amount of vinyl-coated fabric per car. Few observers expect the automotive industry to continue at the present 8-million unit rate, despite the optimism expressed by automotive sales managers. Somewhere between 5.8 and 6.5 million units total is the most common estimate for 1955. An average of at least 2½ lb. of resin is used per car in the coating of fabric for autos, so it is easy to see what will happen if a strike curtails auto production or if the auto manufacturers' present 8-million rate should drop to a 5.5-million rate.

Vinyl-coated fabrics are definitely on the march to obtain increasing permanent markets, in furniture as well as automotive upholstery, but they could have a bad setback late this year if there should be a drastic decline in automotive production.

The other big increase in vinyls—floor coverings—looks sound and permanent. Resin consumption may get close to averaging 4 million lb. a month in 1955 compared with around 3 million a month in 1954. The end of the floor covering replacement season comes in June, after which it will be easier to estimate the total for the year. Except for a possible decline in home construction, there is little in sight to stop this growth. Even a housing decline might not hurt much since vinyl is usurping flooring markets once held by other materials, and is growing on a horizontal as well as vertical basis. It should get up to around 70 million lb. a year before it starts to level off.

Rigid or unplasticized vinyls (except phonograph records) play no great part in the vinyl totals as yet since total volume is small—possibly somewhere in the 10-million lb. range—but they are beginning to grow.

An interesting recent development which should help growth in rigid vinyls was reduction of the rigid vinyl compound price from 52 to 45½¢ a lb., which, taking into account specific gravity, makes it about the same price as the competitive material, modified styrene-acrylonitrile.

All of these factors help to explain why vinyl chloride sales have been running at a 480-million lb. annual rate. Never before has the industry averaged a 40-million lb. monthly volume over such an extended period. Naturally, the industry is cautious of a boom psychology. If sales for wire coating and fabric coatings continue their recent fantastic rate of increase much longer, the industry prognosticators are going to be more surprised than the elephant who was attacked by a mouse.

Sales of all vinyl chloride resins in 1954 were thought to be about 400 million lb., exclusive of 12 million lb. or more of imported resin. The U. S. Tariff Commission's total on their monthly reports shows about 417 million lb., but if past history is any indication, their later annual report will revise those figures downward. The MODERN PLASTICS' estimate for 1954 sales was only 375 million lb. of domestic resin sales, but that estimate was made in September when almost no one foresaw the big months coming up in the usually low November and December months which eventually turned out to be two of the biggest volume months known up to that time. We are happy to call attention to and correct that forecast with a statement that shows an even better state of affairs.

Capacity for vinyl chloride production in the United States is now thought to be well over 600 million

*Reg. U.S. Pat. Off.

5-ton mold of CRUCIBLE CSM 2 produces butyrate hobby horse

Five tons of Crucible CSM 2 mold steel went into this two-cavity mold built by the Enduro Tool and Engraving Company, for Wonder Products, manufacturers of a new plastic hobby horse. Body of the horse, injection molded by Ger-Ell Manufacturing Company, is made of 5½ pounds of medium-flow ivory butyrate, in a mold measuring 40 x 18 x 55 inches, and weighing over 10,000 pounds.

It's with good reason that Crucible mold steels are specified for the big jobs. Made by the electric furnace process in the country's largest tool steel mill, Crucible mold steels actually *are* tool steels. And because they are tool steels you can be sure of uniformly high quality from piece to piece.

So, no matter how large or small your next job may be — call Crucible for your mold steel needs.

CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking **MOLD STEELS**

CRUCIBLE STEEL COMPANY OF AMERICA • TOOL STEEL SALES • SYRACUSE, N. Y.

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lb., maybe 650 million lb., including the expansion just announced by Monsanto, but it would take considerable time to train new workers and obtain supplies to put all facilities into operation.

A sideline of the vinyl boom has been the phthalic anhydride situation. A year ago phthalic was in good surplus—today it is tighter than a frozen fire plug. There have been complaints that suppliers were building inventories, but investigation indicates that they are sending it out as fast as their plants can produce. The jam is no doubt due to increasing need for its use in vinyl plasticizers and in alkyd paint for automobiles (4 lb. per car at least for all General Motors autos), plus a decline in naphthalene imports from Europe of about 80 million lb. in 1953 to 55 million lb. in 1954. The Europeans need more naphthalene for their own use than they once did. Top production capacity for phthalic in this country is about 30 million lb. a month. In December 1954, over 28 million lb. was produced, in contrast to 20 million lb. the same month in 1953.

New Entrant in Polyethylene

LATEST in the chain of polyethylene plants building up in this country is the new National Petro-Chemicals Corp. structure at Tuscola in East Central, Ill. It came on stream in March. Tuscola is a town of some 3000 people about 20 miles south of Champaign and 140 miles straight south of Chicago. If a triangle were drawn with 40- or 50-mile sides, Tuscola would be the western point with Terre Haute, Ind., the southern and Danville, Ill., the northern points. The company makes quite a point of its central location in the U.S. which places them in the heart of a great marketing area. Except for the original plants which were at Charleston, W. Va., all other polyethylene manufacturing plants are in Texas, although one is now being built in California.

National Petro-Chemicals Corp. is a joint enterprise of National Distillers Products Corp. and the Panhandle Eastern Pipeline Co. The selling organization is U.S. Industrial Chemicals Co. which is a division of National Distillers Products Corp. The trademark for this polyethylene is Petrothene.

The natural gas from which the polyethylene is produced, as well as ethyl alcohol and ethyl chloride, comes from Panhandle's compressor station at Tuscola which in turn is one of the stations on the great pipeline from Texas to the Eastern Seaboard. Capacity for polyethylene production at Tuscola is listed at 26 million lb. a year, with plenty of room for major expansion facilities to meet expected increased demand.

U.S.I. thus becomes the sixth source for high molecular weight polyethylene in this country. Total announced capacity of all six companies is now almost 440 million lb. a year, or 22 million a month; but it is doubtful that the recent arrivals will operate at capacity for some time to come. Polyethylene is one chemical that can be brought into production in small quantities and then increased as more reactors are started. Furthermore, it always takes time to smooth out the operation before the operator can be assured of a consistent "A" grade resin.

In addition to the above-mentioned capacity, there are two more companies who expect to enter the field this year with an additional increment of 25 million lb. each and the California plant will start up early in 1956 with 60 million more. And every company now involved has let it be known that they expect to expand their present or announced capacity.

U.S.I. has some interesting sales pitches that it is going to use in merchandising its product.

First, it is asserted that its completely integrated plant, from natural gas to finished Petrothene, makes production control more accurate, especially at the important step of purifying the ethylene. It expects to produce a fully homogeneous product with such consistency from batch to batch and month to month that no user will complain because a repeat order, say, in June was not the same as received in January.

The claim to uniformity is based on ability to produce material with a consistent melt index. Company technicians assert that production rate at the processing level is affected by both molecular weight and melt index of the polyethylene. A pipe producer, for example, would like to extrude at a rate of at least 70 to 80 lb./hr., yet there are times when his rate may be only 40 lb./hr. because of variation in the material. Similarly, film producers may have cause to vary their production rate all the way from 120 to 160 lb. an hour.

U.S.I. technicians assert that the uniform melt index of their material will cut down the necessity for such wide rate of variation. The melt index average for most molding and extrusion grade polyethylene is about 2, they say, but can range all the way from less than 1 up through 7. U.S.I. expects Petrothene to be consistent in melt index. Thus, Petrothene 100 at a base price of 43¢ a lb. will be "2½ m.i. on the nose." Petrothene 200 at 41¢ will have a 2½ melt index average.

And with that kind of a sales talk, U.S.I. salesmen assert that they are going to concentrate on the 43¢ material and build a company reputation for a quality product.

S.P.E Scholarship

FIRST scholarship in plastics engineering has been awarded to Lowell Technological Institute by the Eastern New England Section of the Society of Plastics Engineers, Inc. The scholarship, which will cover a full year's tuition for a deserving student, is part of a program set up to interest a greater number of institutions in considering plastics courses and to make high school students aware of the future awaiting them should they select plastics engineering as a career.

Hollow Molding Process

BY USING a new molding technique developed by Commonwealth Plastics Corp., 102 Adams St., Leominster, Mass., odd-shaped reinforced plastics products, both small and large, can now reportedly be molded in one piece.

According to company officials, the technique, known as the hollow molding process, can be adapted to the production of reinforced-polyester products which previously had

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to be made in two sections and then joined together. A hollow ball, for example, it is claimed, can now be molded in one piece with no openings and with relatively even wall thickness.

In contrast to products produced by other methods, in which the reinforced plastics material has to be stretched during molding, the new technique is claimed to result in products with higher quality surface finish, more uniform coloring, and greater strength. Fillers are selected to insure long life and good shock resistance.

The company further claims that on small odd-shaped items made by the new process, savings in materials costs can be realized. By eliminating the need for expensive dies, the process is stated to make short runs economically practical in many cases and it is reported that certain large items can be made at lower costs than with other techniques.

Progress in Printing on Polyethylene

MORE than 60 licenses in the United States and in Europe have been granted to converters of polyethylene by Dr. Werner H. Kreidl of Kreidl Chemico-Physical Co., 57 W. 58th St., New York, N. Y., for treating polyethylene film to obtain a better printing surface. Latest development, according to Dr. Kreidl, is his new patent, U.S. 2,704,382, March 22, 1955, which permits incorporation of his process unit at the feed end of the printing press.

The Kreidl process employs neither chemicals nor corrosive gases and can be used on gusseted tubing, odd-size bottles, and coated paperboard at high or low speed as a separate operation or combined with extrusion or printing. Dr. Kreidl states that Frank Egan & Co. is now building a high-speed (300 to 400 ft./min.), 40-in. wide standard unit for his licensees that sells for about $8000. The Kreidl engineering service can also furnish equipment for attachment to existing extruders, rewinders, presses, etc., that ranges in price from $1000 to $5000.

A further recent development for utilizing polyethylene in packages has been the announcement of new adhesives by various producers. These new adhesive formulations may be either 50% water emulsions or hot melts. Since polyethylene surfaces when treated by the Kreidl or other processes become wettable, these new adhesives can be used for sealing. They are effective on both film and on polyethylene-coated materials, such as paper or cellophane. These adhesives should simplify production of polyethylene bags on conventional bag-making machines.

Polyester Paste Colors

REINFORCED plastics processors frequently find that paste colors give better results in many applications where dry colors are impractical. Furthermore, many plants do not have the equipment necessary to mix dry colors. For those reasons Ferro Corp., 4150 E. 56th St., Cleveland, Ohio, has concentrated on developing special paste colors for use with polyesters.

Ferro found that inorganic ceramic colors, the most stable of all colors produced, were not strong enough to give many of the darker shades desired when used with polyester compounds that are heavily loaded with white fillers. On the other hand, most of the strong organic colors did not have the stability of inorganic ceramic colors. Consequently, the company conducted extensive laboratory tests to find five of each that were best for tinting strength and color stability during and after molding and dispersion. With those 10 colors, plus black and white, Ferro has been able to meet most specifications for shade, stability, and dispersion.

The five inorganic colors are composed of cadmium, selenium, cobalt, titania, copper, chrome, and other inorganics. The organic colors are mixtures of organic compounds and, in some cases, are precipitated on inorganic bases.

The 12 colors can be purchased in powder form as well as in paste, with the exception of black which is not sold in powder. In the powder form, users can premix with a small amount of resin and then add it to the batch. The paste colors can be stirred directly into the batch or, if desired, can be color-matched and compounded in the Ferro plant before delivery. Where the shelf life of the polyester paste or powdered color, mixed with resin, is too short for practical production applications, the company will supply a liquid set retarder which is compatible with the polyester resin. This retarder keeps the catalyzed resin in a liquid condition so it can be satisfactorily used after standing for lengthy periods of time.

Butyrate Pipe in Movies

THIRTY minutes of education on what's going on in the butyrate plastics pipe field will be the reward of anyone who is privileged to see Eastman Chemical's new movie, "Plastic Pipelines." The film emphasizes the ease of handling and installing cellulose acetate butyrate pipe, with particular attention to the simplicity involved in joining the pipe lengths and fixtures by means of slip sleeve couplings and liquid solvent.

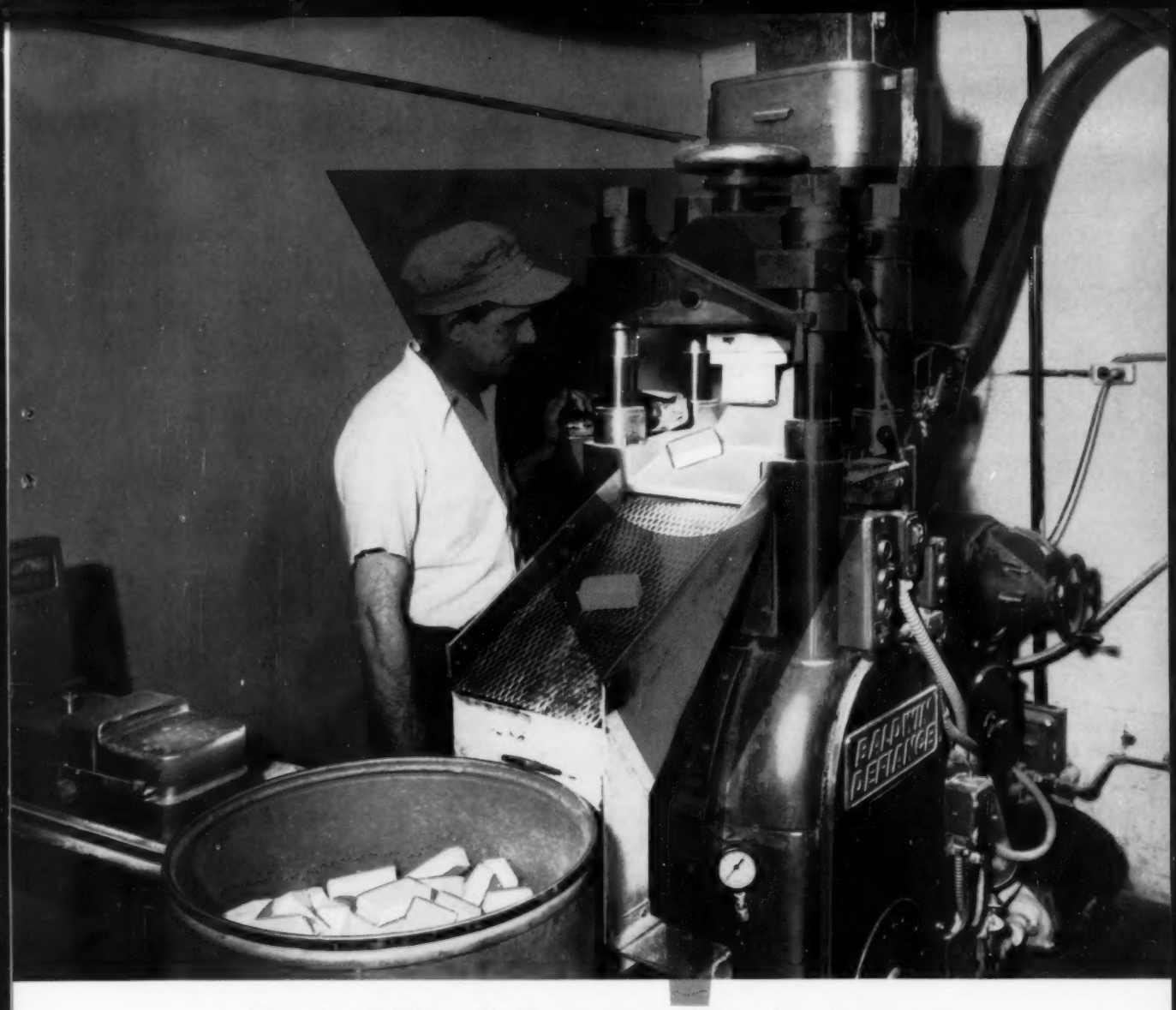
Installations of butyrate pipe shown in the film include pipe for handling corrosive water; nursery irrigation; natural gas conveyor from house to main (both new and replacement); syphon irrigation; gas mains; conveyor tubes on the manufacturing line for paper cups; and petroleum lines where salt water or paraffin is a problem.

A complete sequence on extrusion is also shown in the movie, which can be obtained on loan from Eastman Chemical Products, Inc., Kingsport, Tenn.

D.A.P. Laminates

THREE new grades of thermosetting laminated plastics utilizing a D.A.P. (diallyl-phthalate) resin base are now being produced by Synthane Corp., Oaks, Pa. Developed as the answer to a number of design problems involving moisture, the company claims that the new laminates show promise in just about every type of electronic device and precision instrument, with particular emphasis upon military components used in damp, humid climates.

The new grades are coded according to filler material. D.A.P.-impregnated canvas (Grade C-104), Orlon (Grade O-104), and woven glass cloth (G-104) all show a number of



Precise filling of dies by Baldwin plastic presses makes compacts more uniform

Baldwin plastic presses with so many exclusive features enable you to compact plastic preforms more uniformly, at less cost.

One such outstanding feature of the Model 20 and Model 45 is the cam controlled feeder. This unique component reduces the tendency of fine and coarse particles to separate . . . assures more uniform table weight. A feeder boot of uniform cross section, ground to perfect fit, permits handling of most materials without vibrating or shaking and minimizes material loss.

This is just one advantage you'll get with the Baldwin Model 20 (75 tons) and Model 45 (200 tons). When investigating these Baldwin Plastic Presses, you'll find they incorporate all these exclusive features . . .

Safeguard lubrication reduces downtime.

Balanced pressure cuts vibration for longer die-set life.

Simple adjustments allow weight-density changes during operation.

Cam controlled feeder assures uniform table weights.

Cleanline design prevents contamination, speeds cleaning.

For more information and specifications write now for Bulletin No. 3103, Department 4126, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

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outstanding electrical properties in laboratory tests. Price-wise, C-104 is least expensive. Due to its canvas filler, C-104 is easily machined and has a high degree of dimensional stability. Grade O-104 is particularly outstanding in that the power factor and dielectric constant show very little change after N.E.M.A. water immersion tests. Grade G-104 possesses the best electrical properties in the dry condition compared to other D.A.P. grades, but shows a somewhat higher rate of change when subjected to moisture.

Maximum operating temperatures vary slightly between grades. Laboratory tests indicate that Orlon D.A.P. will withstand continuous temperatures of 225° F.; canvas, 275° F.; and glass fabric, 325° F. without affecting either the mechanical or electrical values.

The new D.A.P. laminates are available in sheet and tube form or as parts fabricated to specifications. Sheet thickness ranges from 1/32 to 1 in. in the case of canvas and Orlon. Glass fabric D.A.P. is furnished in sheets of 1/64 to 1 in. thick. Grades C-104 and G-104 can be supplied in tubing but as yet size limitations have not been firmed.

Dibutyl Fumarate

SEMI-COMMERCIAL quantities of dibutyl fumarate, a reactive resin intermediate, are available from Monsanto Chemical Co.'s Organic Chemicals Div.

The compound is a clear, essentially colorless liquid which will homopolymerize. It is also reported that, by using it with various monomers under adjusted reaction conditions, polymers can be made which range from brittle resins to soft, internally plasticized materials.

Copolymers of dibutyl fumarate with vinyl acetate, vinyl chloride, acrylates, and styrene are of special interest in formulating surface coatings, free films, permanently tacky adhesives, fibers, synthetic lubricants, and additives for oil.

As a chemical intermediate, dibutyl fumarate yields substituted succinates readily with the addition of halogens, aldehydes, thiols, and similar compounds. It readily undergoes the Diels-Alder reaction with conjugated dienes.

Technical information on properties of the compound and an extensive bibliography on its reactions may be obtained by requesting Monsanto Technical Bulletin No. ODB-54-18 from the company's Organic Chemicals Div., St. Louis 1, Mo.

One-Package Epoxy

DEVELOPMENT of a one-package epoxy casting material, called Epoxyn E-PC-106, has been announced by Co-Polymer Chemicals, Inc., 12350 Merriman Rd., Livonia, Mich.

The company states that the necessity for adding a catalyst before use, long a stumbling block in epoxies, is eliminated in the new material, and yet the resin is completely stable at ordinary storage temperatures.

Normally supplied as a filled or pigmented liquid resin, the material can also be supplied clear or in various colors.

Clear, Flexible Cast Vinyl Sheeting

WINDOW-CLEAR, flexible cast vinyl film and sheeting, produced in continuous sheets and in thicknesses never before achieved commercially, have been announced by Bakelite Co., a Div. of Union Carbide and Carbon Corp., 300 Madison Ave., New York 16, N. Y. Krene cast film and sheeting reported to be of unusual clarity and toughness, as compared to other vinyl materials, has been developed in thicknesses ranging from 0.005 to 0.010 in., according to J. B. Knowles, manager of the Film and Sheeting Div.

Mr. Knowles states that high clarity combined with exceptional tear strength and flexibility opens up whole new fields for product application of clear film and sheeting. Markets for the material exist in inflatable beach items, glazing, and visible packaging for such items as dry goods and hardware. Handbags, book covers, umbrellas, shoes, gaskets, and similar items of everyday use are also prime prospects for the new cast film.

Previous to this development, the only commercial process for producing transparent sheets was by the costly polishing of single-calendered sheets under pressure. Casting the new Krene on a stainless steel belt in one continuous operation produces a mirror-finish smoothness and clarity comparable to press-polished calendered sheets, but with greater economy. The new process also maintains a higher degree of tear strength for given thicknesses in the new cast film and sheeting, both length-wise and cross-wise, as compared with calendered material.

Produced in standard widths up to 36 in. wide, the Krene vinyl cast film and sheeting is available in continuous 100-lb. rolls. The new process maintains tolerances within ±5% of a given thickness, and keeps contamination and pinholes to a minimum.

Extruded Acrylic Sheet

COMMERCIAL production of extruded acrylic sheet has been started by Gering Products, Inc., Kenilworth, N. J., at competitive price levels.

The material is available in 0.060- to 0.125-in. gages and maximum widths of 54 in., and 76-in. lengths. The company states that the original goals of uniform tolerance, good surface, low shrinkage (less than 1%), and easy forming and machining have been attained.

The acrylic sheet is being specifically manufactured for applications in fluorescent light diffusers, outdoor signs and letters, display racks, and similar products.

Vinyl-Coated Wallpaper

EASE of cleaning is a basic advantage of a new vinyl-coated wallpaper called Glendura, manufactured by Imperial Paper & Color Corp., Glens Falls, N. Y. The product can be cleaned with soap and water or, if the dirt is especially heavy, a fine bristle brush can be used. A dry cleaner or other bleach will remove the more stubborn stains.

The wallpaper is completely saturated with B. F. Goodrich Chemical Co.'s Geon vinyl. This coating protects the wallpaper from dirt, ink spots, crayon marks, grease spatterings, and other stains. Since the foreign materials are stopped at the surface, they can be wiped off with

FEWER REJECTS with faster cycles is the type of performance you get with Lustrex Hi-Flow 55.

IT TAKES LUSTREX Hi-Flow 55

for fast molding of these fine-toothed combs!

20 CAVITIES PERFECTLY FILLED in a single shot! Cycle time, 21 seconds! Much shorter than average, thanks to Lustrex Hi-Flow 55 styrene.

HERE'S THE STORY of how the *right material* ended short shots and upped cycle speed at Arma Plastics.

In molding combs, it takes an unusually high number of cavities and a fast, uniform cycle to achieve profitable volume production.

Lustrex Hi-Flow 55 styrene gives perfect results in such an operation.

The owner-partners of Arma Plastics, Brooklyn, N. Y. attest to this after experience with many materials. They've settled on the famous Monsanto material, they tell us, because it gives them a cycle speed way better than average for this sort of job.

Most of the combs in the line produced by Arma are in solid color, with very fine teeth. Rejects due to short shots and streaky color dispersion dropped considerably when Lustrex Hi-Flow 55 was put on the job. It flows smoothly, perfectly into tiniest reaches of the cavity, with excellent color dispersion. Rejects are rare. Production is up to a new high.

For proof that Monsanto's soft-flowing styrene compound can improve the quality and sales appeal of the products you mold, try Lustrex Hi-Flow 55 styrene. Write Monsanto Chemical Company, Plastics Division, Dept. MP-5, Springfield 2, Mass.

Speed Cycles and Cut Costs with

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HI-FLOW 55
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ease. Glendura can be washed as often as necessary.

Unlike many plastic-coated wallpaper products which have a gloss or sheen, Glendura has a matte finish which is a characteristic of the finest wallpapers. The product is available in soft pastel tints or in deep decorator tones and in a wide range of designs for every room of the home.

Glendura can be hung like ordinary wallpaper; it is stated that no special tools or adhesives are required.

Odor Inhibitor

DESIGNATED Compound 19, a white to buff-colored crystalline bis-phenol which is soluble in fats, oils, and organic solvents, but insoluble in water, has been developed by Sindar Corp., 330 W. 42nd St., New York 36, N. Y.

The new anti-oxidant is reported to inhibit rancidity in fatty acids and their derivatives, as well as prevent odor development during the manufacture of metal stearates. Other applications are being developed by the company.

Metallizing Process

HIGHLY versatile materials are now being offered to product designers, engineers, and decorators with the use of a new high-speed process for metallizing plastic films installed by National Metallizing Corp., 930 Washington Bldg., Washington 5, D. C. Produced under a patented process based on the experience of 30 years of high vacuum coating techniques developed by Dr. Paul Alexander, Princeton, N. J., these films, including Mylar, can be sewn and eyeletted, lend themselves easily to vacuum and other forming, and can be die-cut. Some of the metallized materials can be heat sealed and printed. They can easily be laminated to vinyls and many other plastics, to textiles of all kinds, to fibrous glass, paperboard, and plywood, and to steel and various metals. Other films being commercially metallized, in addition to Mylar, are polyethylene, acetate, styrene, and cellophane. The most popular metallic deposition is aluminum, but metals such as copper and pure gold are being used.

National Metallizing Corp. equipment is now producing materials in 38-in. widths; additional machinery will supply materials in 40-in widths, and by the end of the year it is reported that new machinery will be turning out materials in 60-in. widths.

Styrofoam in Color

COMMERCIAL production of colored Styrofoam (expanded polystyrene) has been announced by The Dow Chemical Co., Midland, Mich. Previously available in white only, the lightweight plastic foam is now furnished in red and in light and dark green. The red and light green foams were developed for use primarily in the display and novelty fields, while the dark green is expected to be of particular interest in the floral field.

The coloring is not a surface coating, but extends throughout the product. Color is added to the foam during the production process.

Colored Styrofoam is offered in two forms—packaged boards, 2 by 12 by 36 in., and unpackaged rough planks approximately 4 by 13 in. by 9 ft. The material is sold by Dow distributors throughout the country.

New Stabilizers

DATA sheets are now available for the first time from Advance Solvents & Chemical Corp., 245 Fifth Ave., New York 16, N. Y., on its latest organo-tin stabilizer, called Advastab T-72. Specifications of the stabilizer are as follows: tin content, 17.0 to 17.5%; color, 5 G.H.; viscosity, Z-2 (G.H.); specific gravity, 1.19 to 1.22; and pounds per gallon, 10.

Although T-72 is now equivalent in stabilizing action to the company's tin mercaptide-type stabilizers such as Advastab 17M, it is suggested as a tin stabilizer to use when the odor of the latter product cannot be tolerated.

The company also announces the development of an organic barium stabilizer, called Advastab BA-13P, which is designed for heat and light stabilization of vinyl compounds.

Advastab BA-13P has been developed as an auxiliary stabilizer primarily for other stabilizing systems to improve their performance. While it will perform as a stabilizer for uses where no prolonged heat treatment or very high temperatures are employed, its main significance is in combination with cadmium and zinc stabilizing systems.

Epoxy Curing Agent

INTRODUCTION of a new modified amine curing agent has been announced by Shell Chemical Corp., 50 W. 50th St., New York, N. Y. Development work has shown the curing agent to be particularly useful in epoxy castings, potting, and adhesives and laminating applications where room temperatures or moderately elevated temperatures of curing are desired.

The company states that the curing agent is expected to find widest usage with the lower molecular weight resins, particularly Epon 828, although it can be used with all Epon resins. In all applications, the low vapor pressure minimizes the odor associated with unmodified polyamines.

Nylon Rod

PRODUCTION of nylon rod as a stock item has been announced by A. L. Hyde Co., Grenloch, N. J. The rods are furnished in Du Pont Zytel 101 in ¼-, ⅜-, ½-, and ⅝-in. diameters and sold in 5-ft. lengths.

The company plans to produce additional sizes in the near future.

Polyethylene-Glass Tape

UNKNOWN industrial possibilities for two new fibrous glass-reinforced polyethylene tapes that may lend themselves to unlimited reinforcing and sealing use in industry are being sought by Minnesota Mining & Mfg. Co., St. Paul, Minn.

Both of the new Scotch brand reinforced polyethylene tapes—No. 875, which is pressure-sensitive, and the non-pressure-sensitive No. 877, which is heat sealable—were originally developed by the company to reinforce the plastic panels of weather balloons used to explore the stratosphere.

The additional strength afforded by the tape, the firm states, make it possible for such balloons to soar to

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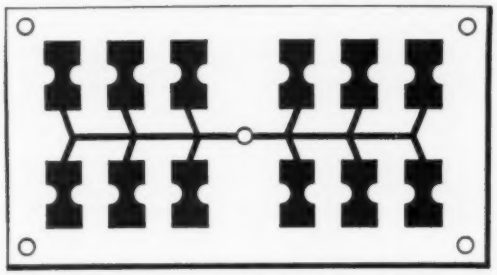
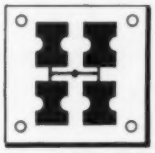
Average Mold Cost $5000



Delivery time 10 to 12 weeks

Small Mold Cost $1750



$3250 saving

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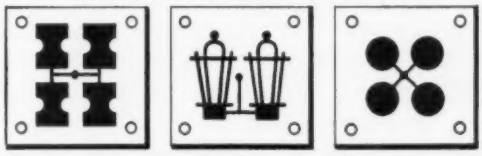

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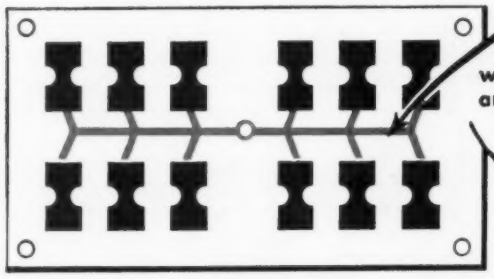
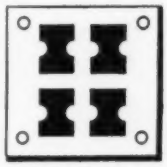


REGULAR TYPE GATING

Sprue and Runner often weigh as much or more than molded article



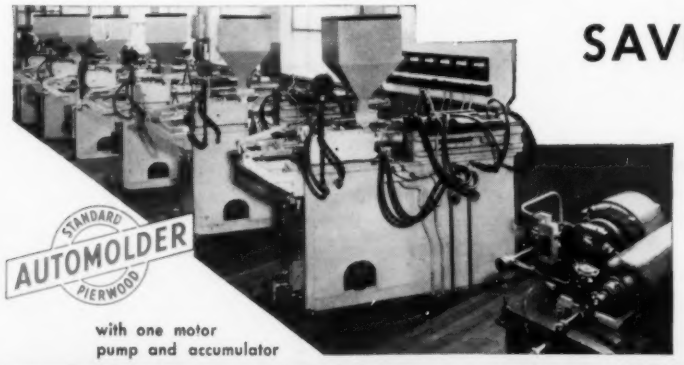
HOT RUNNER

NO SPRUE OR RUNNER

Hot Runner Molds

Modern - Efficient
Economical
Material Saving
Labor Saving
Production Increase

You can save on OPERATING COST



with one motor
pump and accumulator

SAVINGS...

LABOR	1 OPERATOR ~~6 OPERATORS~~
POWER	2 15 hp MOTORS ~~6 15-20 hp MOTORS~~
MAINTENANCE	~~$~~ ¢

Cost of operating 6 machines unbelievable figure of less than 50 cents per hour per machine

BUILT BY **STANDARD TOOL COMPANY** 83 WATER ST., LEOMINSTER, MASS.

DESIGNERS AND BUILDERS OF MOLDS FOR PLASTICS FOR FORTY-THREE YEARS

Australian Plant, Standard Tool Co. (of Australia), PTY. LTD., Sydney

Foreign Representatives, OMNI PRODUCTS CORP., 460 Fourth Avenue, New York 16, New York

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new altitude records, permits them to stay aloft longer, and increases their load-carrying capacity. Hundreds of continuous glass filaments that reinforce the tape "like steel rods reinforce concrete" give the tape its strength.

The only specific applications known for the tapes at this time, other than for balloon fabrication, 3M reports, are the woven wire and silk screen industry where they are used for edge reinforcement and the construction industry where they are used to reinforce lightweight plastic tarpaulins.

New England S.P.E.

SELECTION of the following group of officers has been announced by the Eastern New England Section of The Society of Plastics Engineers, Inc.:

President: Harry Connors, B. F. Goodrich Chemical Co. Vice president: Robert Davenport, Gregstrom Corp. Secretary: Josiah Crosby, Hood Rubber Co. Treasurer: Ralph L. Mondano, Raytheon Mfg. Co.

The national director is Richard Beckwith, The Dow Chemical Co.

Nylon 8

FIRST license to produce and commercially market Nylon 8, a new plastic with greatly increased life-prolonging qualities for industrial and consumer products, has been granted by Du Pont to Belding Corticelli Industries, Inc., newly established subsidiary of Belding Heminway Co., Inc., 350 Fifth Ave., New York 1, N. Y. The parent company claims to be the first to use nylon in sewing thread.

Some 15 years of research by Belding Heminway on original nylon and this new "tempered" material preceded the announcement. Designated as Nylon 8 by Du Pont, the material as produced in commercial volume for the first time by Belding Corticelli will be known as BCI nylon.

Nylon 8 is produced at the subsidiary's newly equipped Putnam, Conn., plant in granular, pellet, and liquid form. Its chief characteristics include high strength and toughness which resist tearing and abrasion. The material will not break from flexing because of high elasticity; it can be used as an exceptional adhesive for wood, metal, glass, and paper; and it will bind pigments to textiles in printing. In addition, the nylon may be used as a fiber binder in the manufacture of non-woven fabrics of rayon, nylon, and cotton, and is a hydrocarbon barrier for rubber fuel tanks, gasoline lines, gaskets, and seals because of its resistance to aromatic aliphatic hydrocarbons.

Coated Glass Bottles

MANUFACTURERS of glass containers are finding increasing interest in emulsifiable A-C polyethylene as a coating for bottles. Produced by Semet-Solvay Petrochemical Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y., this low-molecular-weight polymer is easy to use since it can be applied from a water system and, therefore, can be sprayed on either or both the inside or outside of irregular shaped containers. Chief attribute of this material is the stable, clear emulsions that may be obtained even in formulations containing up to 40% solids.

As a coating on the inside of glass bottles, A-C polyethylene promotes slip for such foods as catsup. It is reported that due to the excellent transparency of the applied film, clarity of the glass is unimpaired and thus sales appeal is not lost. Coated on the outside of the containers, the film serves a protective function—it provides mar-resistance to scratches that reduce strength and spoil the appearance of the glass. This also cuts production loss. In the case of returnable containers, greater economy can be expected through increased trippage.

T.C.P. from Cabot

COMMERCIAL availability of Cabflex T.C.P., tricresyl phosphate, made from petroleum cresylic acid, has been announced by the Plastics Div. of Godfrey L. Cabot, Inc., 77 Franklin St., Boston, Mass. Twelfth in the Cabot line of plasticizers, Cabflex T.C.P. has been specifically developed for use in the manufacture of wire vinyl insulation.

The company states that especially significant in the production of this newest plasticizer is the fact that a compound made with both the new T.C.P. and D.D.P. (di-decyl phthalate), has already been approved by Underwriters' Laboratories, Inc. for use in both 80 and 90° C. vinyl wire insulation.

Diallyl Phthalate by Ohio-Apex

CONSTRUCTION on a new building has been started by Ohio-Apex Div., Food Machinery & Chemical Corp., for the manufacture of a diallyl phthalate prepolymer, to be sold under the name of Dapon. The plant will be built on the site of present operations in Nitro, W. Va.

Dapon resin was announced a short time ago by the company and has been produced in a small plant for approximately a year. The material is claimed to be particularly valuable in the manufacture of fibrous glass laminates for structural and electrical applications. It is also used in the production of molding powders for high resistivity electrical applications and in decorative laminates. The product will be sold by the firm and distributed through its existing trade outlets.

This is the first entrance of Ohio-Apex into the manufacture of resins. Until recently the company's products have been confined to the manufacture of plasticizers and inorganic chemicals.

Extrusion Laminator

PURCHASE of an additional polyethylene extrusion laminator for its Milford, N. J., mill has been announced by Riegel Paper Corp., 260 Madison Ave., New York 16, N. Y. The machine will be used to polycoat the company's glassine papers.

The laminator, manufactured by Frank W. Egan & Co., will coat thicknesses of 0.0005 to 0.0015 in. and higher. It includes flying splice unroll and reroll equipment, an Egan 4½-in. diameter extruder, and a Reliance Electric drive.

Plastics Fair Changes Date

ACCORDING to an announcement by Philip M. Kent, exposition director of the World Plastics Fair and Trade Exposition, the fair has been postponed. The new dates are Octo-

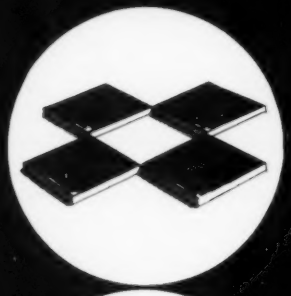
uct Development, Carbide and Car-

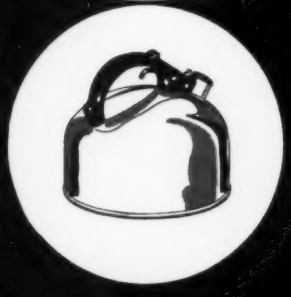
Give your products the

Smart Black Look

WITH WITCO-CONTINENTAL

CARBON BLACKS





Nothing matches black for smartness and practicability . . . whether it's floor tile, furniture upholstery, handles for pots and pans . . . or any one of a hundred other uses. And to make sure the black you use meets the requirements of your product, specify one of Witco-Continental's carbon blacks for pigmenting.

Witco-Continental channel and furnace blacks are made in 5 modern plants under rigid quality control to give you tops in dependable performance. They've been noted for their uniformly high quality for nearly 30 years.

WITCOBLAK® No. 11—low color channel
WITCOBLAK No. 32—maximum jetness at low cost
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WITCOBLAK No. 100—jetter color, Nigrometer 74
WITCOBLAK HITONE—jet black, Nigrometer 71

and . . . to meet your other plastics requirements . . .

Witco offers a complete line of:

METALLIC STEARATES
STAYRITE* (Stabilizers)
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WITCARB® (Precipitated Calcium Carbonate)

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For molding escutcheons for Amana Freezers

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ber 5 to October 9 and the exposition will be held in the National Guard Armory, Los Angeles, Calif.

The announcement came after a series of meetings held by the exposition directors and S.P.I. officials attending the recent Reinforced Plastics Conference in Los Angeles. The new dates will provide more time for plastics manufacturers, machinery firms, and resin suppliers to ready exhibits for the exposition. The dates set up will not be in conflict with any other major meetings of the S.P.I., S.P.E., or any of their regional chapters.

Another Isocyanates Plant

CONSTRUCTION of a multi-million-dollar plant to produce organic isocyanates at Moundsville, W. Va., has been announced by National Aniline Div., Allied Chemical & Dye Corp.

Scheduled for completion in early 1956, the plant will be a completely integrated organic isocyanates facility, with all chemical raw materials supplied from the Allied Chemical organization. The plant has been planned for production of a varied line of isocyanates, including the di-isocyanates of toluene (T.D.I.), di-tolyl (T.O.D.I.), and diphenylmethane (M.D.I.), which are currently being supplied by National Aniline's interim commercial production at Buffalo, N. Y.

Located on the Ohio River, just south of Moundsville, the new plant will adjoin Solvay Process Div.'s new chlorine, caustic soda, and chlorinated methanes plant and National Aniline's recently completed maleic anhydride, fumaric, acid, and catalytic aniline operations.

National Aniline also plans to provide a full range of coloring materials so that the new foams and other polyurethane products may be produced in desired colors.

Summer Session on Plastics

ENGINEERING and structural principles in the design of building products, of which plastic materials are a basic component, will be offered as a two-week special program in the 1955 summer session at Massachusetts Institute of Technology, Cambridge 39, Mass., from June 14 to June 24. Tuition is $160, payable upon notification of admission.

The program will consist of two integrated lecture series covering technical fundamentals and design principles, accompanied by individual design projects. The session will be under the immediate direction of Burnham Kelly, associate professor of City Planning and chairman of the Advisory Committee on the Plastics in Housing Project.

Methacrylate Price Reductions

PRICES of methyl methacrylate molding material have been reduced for the second time in four months by Rohm & Haas Co., Washington Sq., Philadelphia 5, Pa.

Under the new schedule, the price of colorless Plexiglas molding powder has been reduced from 68 to 65¢ a lb. for minimum truckload quantities, and colored material from 72 to 69¢ a lb. Custom colors manufactured to order were reduced from 72 to 69¢ a lb. for minimum truckload quantities.

Price reductions of approximately 10 and 12% for clear and colored Plexiglas R, cast methyl methacrylate sheet, were also announced. In addition, three thinner gages, 0.060, 0.080, and 0.100 in. have been added to the line. Plexiglas R is used for outdoor signs, industrial glazing, dome skylights, light diffusers, and other commercial applications.

Plexiglas R is a general-purpose acrylic sheet with the same physical and chemical properties as standard Plexiglas. It is supplied unmasked and untrimmed in standard packages in minimum quantities of 500 sq. ft. for colorless material and 750 sq. ft. in colors.

Officers for C.C.D.A.

ELECTION of new officers for the year beginning July 1, 1955 has been announced by Commercial Chemical Development Association, 100 Park Ave., New York 17, N. Y., as follows:

R. L. Bateman, director of Product Development, Carbide and Carbon Chemicals Corp., is completing his term as vice president and will serve as president starting July 1.

F. S. Swackhamer, manager of Shell Chemical Corp.'s Resins and Plastics Dept., has been elected vice president for 1955 and president-elect for 1956.

J. M. Rogers, head of the market development section of Minnesota Mining & Mfg. Co.'s Fluorochemicals Dept., was re-elected treasurer.

J. R. Dudley, vice president in charge of research and development, Carwin Chemical Co., was re-elected executive secretary.

D.I.D.P. Production

ADDITION of Pittsburgh PX-120 (di-iso decyl phthalate) to its family of phthalate plasticizers has been announced by Pittsburgh Coke & Chemical Co.'s Plasticizers Div., Pittsburgh 19, Pa. PX-120 is claimed to be particularly suitable for high-temperature processing cycles.

Vinyl products containing PX-120 exhibit long life, a high degree of resistance to extraction by various materials, and low-temperature properties comparable to those provided by D.O.P.

The company also announces that PX-108 D.I.O.P. has been approved for use in non-toxic vinyl formulations, which will enable plastics manufacturers to use it in the production of wrapping film for most foods and for making intravenous vinyl tubing.

Development of this new use for di-iso octyl phthalate is a joint accomplishment of Pittsburgh Coke & Chemical and Indoil Chemical Co., Chicago, Ill.

Contour Packaging

FORMING plastics sheet into contoured bubble packages by a reportedly new technique known as the Valentine Forming Process is claimed to offer several advantages over present forming methods. Kontoor-Pak, Inc., Rochelle Park, N. J., has been organized to produce and sell the products made by the new method. Bernard L. Thompson, Ltd., 130 W. 42nd St., New York, N. Y., will also handle sales.

According to company officials, the technique embodies new principles for heating and forming sheet that are claimed to make for faster production and better detail. Com-

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terial, called Part-A-Part, is said

For molding escutcheons for *Amana* Freezers

Photo courtesy Prolon Plastics Div.

. . . here's what Prolon Plastics Division (PRO-PHY-LAC-TIC BRUSH COMPANY) has to report about

Cascade pre-hardened DIE STEEL

Following are comments on the use of Cascade precipitation hardened die steel by Prolon Plastics Division, Pro-phy-lac-tic Brush Co., in the above molding job at the Prolon plant in Florence, Mass.

Photo courtesy Amana Refrigeration, Inc.

1. *Cascade's excellent finishability saves time and labor in initial costly polishing . . . also less polishing time required when molds are removed from storage for re-use.*

2. *The mirror-like finish obtainable on Cascade surfaces results in an excellent high finish on molded parts.*

3. *Cascade's outstanding weldability allows mold rework, even in comparative large areas, to meet latest engineering design changes of molded part at minimum expense.*

Cascade's excellent finishability and weldability (a result of Latrobe's exclusive precipitation hardening process) have been noted by many leading molders and moldmakers. These are just two of several properties of Cascade that make it a preferred choice among prehardened steels for plastic injection molds. Call your nearest Latrobe representative today for complete details.

Branch Offices and Warehouses

Atlanta, Boston, Buffalo, Chicago, Cleveland, Dayton, Detroit, Hartford, Los Angeles, Milwaukee, Newark, Philadelphia, Pittsburgh, St. Louis, St. Paul, Toledo

Sales Agents

Charlotte, Dallas, Denver, Houston, Salt Lake City, Wichita

European Offices:

Geneva, Brussels, Paris, Milan, Rotterdam, Dusseldorf

LATROBE STEEL COMPANY

LATROBE, PA.

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pany officials also report that the method enables the 90° flange inherent in products made by other forming processes to be rolled under to a controlled width. The roll-back flange can thus be used as a lip for a closure or as a surface for gluing and mounting display pieces.

This roll-back flange construction is especially adaptable to the design of packages in which a formed plastic sheet is to be slipped over cardboard. Using the grooves of the flange, the card easily slides into place.

The contoured plastics bubbles made by the method — whether with a normal 90° flange or with the roll-back flange — can be used in the packaging of small and hard-to-merchandise items, such as phonograph needles. Novelty packages formed with integral covers are claimed to be another possibility. The lid and base of the package are formed as a single continuous piece and are hinged along a scored line. The lid closes by locking the lid flange over the lip provided for it on the base of the package.

Reinforced Plastics Citations

FOR the first time, the Executive Committee of the S.P.I. Reinforced Plastics Div. has awarded plaques and pins to individuals who have rendered outstanding services to the reinforced plastics industry.

The initial awards, issued at the annual banquet of the division on February 10, were presented to John B. Alfers, U. S. Bureau of Ships; Hiram McCann, editor, MODERN PLASTICS Magazine; and Sherman Stambaugh, public relations manager, Owens-Corning Fiberglas Corp.

Nylon Prices

REDUCED prices for Zytel nylon resin molding powders have been announced by Du Pont's Polychemicals Dept. as follows:

Zytel 101, general-purpose nylon, has been reduced from $1.60 to $1.45 a lb. on orders ranging from 2000 to 20,000 lb.; orders of a truck-load or more are now priced at $1.43½ a lb.; orders of less than one case will remain at the old price of $1.60 a pound.

Zytel 211, which sold at $2.50 a lb., has been reduced to conform with the price for Zytel 101. Du Pont describes Zytel 211 as a material "which is similar in composition to nylon resins imported from abroad." To the trade that means that this is the nylon derived from caprolactam which is now being offered by several importers. It has also been put into production by the National Aniline Div. of Allied Chemical & Dye Corp.

Evaluating Plastisols

ROTATIONAL molding equipment has been installed by Flexible Products Co., 312 Dobbs St., Marietta, Ga., formulators of vinyl plastisols and organosols. The new equipment will be used by the company for evaluation of its compounds before they are sold to the public. It will also be available to customers for sample production or product and mold development.

Contact Adhesive

DEVELOPMENT of an improved contact adhesive, STIX, which makes it possible for anyone to laminate Formica, Micarta, Consoweld, and Panelyte to wood, without the use of heat or pressure, has been announced by Adhesive Products Corp., 1660 Boone Ave., New York 60, N. Y.

When using STIX, the surfaces to be adhered are allowed to dry for 30 minutes. The coated surfaces are then placed in contact with each other and an instantaneous bond results which cannot be separated. STIX is so formulated that the bond improves with age, and is also heat resistant.

The product is available in pint, quart, and gallon cans, as well as 55-gal. drums, and is sold at leading hardware stores and lumber yards throughout the country.

Mold Release

DESIGNED as a release agent for polyester resins, a new film-forming material has been developed by Ram Chemicals, 200 E. Olive St., Gardena, Calif. The material, called Part-A-Part, is said to be a relatively non-toxic, very low-flammability solvent, formulated for spraying or brushing onto a variety of mold surfaces. When dried, the continuous film produced is impervious to liquid polyester resins and is readily removed from cured parts by peeling or washing with water. The resultant polyester surface is clean and ready for painting.

The company states that Part-A-Part is ideally suited for the coating of phenolic, polyester, epoxy, plaster, metal, wood, rubber, wax, and most painted surfaces. The properties of the new film are particularly valuable in the manufacture of car bodies, boats, radomes, and large parts.

Silicone-Glass Pressure-Sensitive Tape

NOW available from Mystik Adhesive Products, 2635 N. Kildare Ave., Chicago 39, Ill., a new pressure-sensitive tape combines both high tensile and dielectric strengths with excellent bonding ability at temperatures ranging from — 100 to 550° F.

Designated as Mystik Brand No. 7000-G, the tape utilizes a fibrous glass backing and newly developed silicone adhesive. It offers a high degree of stability in the presence of many acids, lubricating oils, ammonia, chlorine, bromine, water, and iodine. Laboratory tests have failed to disclose any corrosive or staining action on a wide variety of materials.

Fully qualified as Class H insulation, Mystik No. 7000-G has already been tested and approved by the United States Navy, Bureau of Ships, for shipboard use.

The company also announces the development of a Mylar film tape, called Mystik No. PD 300, which utilizes a silicone adhesive with a dielectric strength of 9000 volts.

In temperature performance tests, the tape has bonded within a wide range—from — 80 to 300° F. It is also claimed to have excellent abrasion resistance as well as shelf aging.

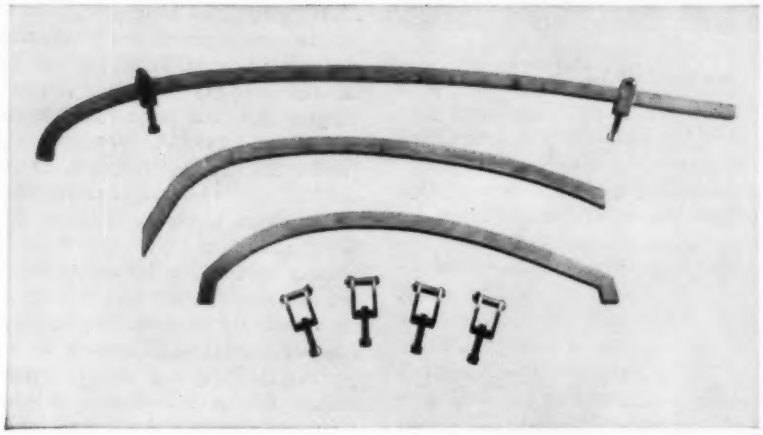
New Saran Monofilament

DEVELOPMENT of a new formulation of saran resin for monofilaments has been announced by The Dow Chemical Co., Midland, Mich. In addition to its use for lawn furniture, automobile seat covers,

DOW

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION



Bending Test Forms and Clamps.

NEW TECHNIQUE OF STRESS MEASUREMENT DEVELOPED FROM STUDY OF POLYSTYRENE BEHAVIOR

In Plastiatrics, as in medicine, sound diagnosis is essential to correct treatment and the cure of problems. That's why The Dow Technical Service laboratories have developed a simplified test procedure for the study of the *crazing* of molded polystyrene . . . a condition which may result from misunderstanding or improper application of a molded plastic part. Of significance to engineers and plastics molders, the new data on polystyrene's "critical elongation" is of fundamental importance in product design and in predicting field service life.

What is Crazing?

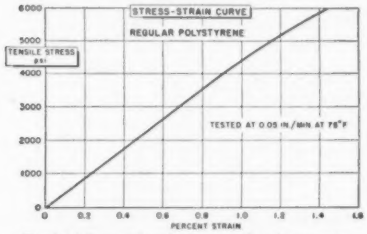
Crazing is the development of fine cracks on or under the surface of molded plastics. Whether or not it progresses to serious proportions is dependent on several variables of exposure and applied stress over a period of time. "Solvent crazing" may be derived from the chemical action of a wide variety of reagents. "Stress crazing" may result from mechanical loading, shock, thermal conditions, or from the molding operations.

Simple Test Developed

To maintain standard conditions while handling of immersing specimens in a variety of reagents, a simple, portable bending form was developed. It's designed to provide a constantly changing radius of curvature and corresponding stress as well as strain in the test specimen. Percent elongations can be calculated accurately and varied over a wide range while cold flow is virtually eliminated regardless of the length of time needed for the test. By close visual examination of the stressed specimen in bright light, it is possible to observe the minute cracks and ascertain the magnitude of the crazing in relation to the amount of stress. Excellent correlations of results have been established with critical elongation values taken from conventional testing equipment, as well as with field tests of molded products. Effects of time, temperature reagents, and exposure can be studied in detail.

Practical Uses for Engineering

From the data, the design engineer can more definitely predict stress behavior of molded polystyrene parts. For example, studies on the effects of various milk products on tumblers indicate varying degrees of useful life. Lactic acid is found to have less affect on weakening polystyrene than butterfat has. Test results established critical stress for skim milk at 750 p.s.i. as against 450 p.s.i. for cream. When the tumbler is subject to very hot water in the presence of cream (butterfat), critical stress is further depressed (to about 200 p.s.i.) leaving little room for internal molding stresses or mechanical leading stresses resulting from stocking, rough handling or dropping. Thus, it becomes possible to predict the margin of residual stress which will result in satisfactory tumblers . . . or to forecast potential crazing difficulties.



Typical Stress-Strain curve of polystyrene.

Free Bulletin Offered

A considerable amount of data on this test method has been compiled and published in a bulletin entitled "The Crazing of Polystyrene." A copy will be sent free upon request. Write to Plastics Sales Department PL 454K, THE DOW CHEMICAL COMPANY, Midland, Michigan.

DOW POLYSTYRENE FORMULATIONS:

- Styron® 666. . . Dow general-purpose polystyrene.
- Styron 688 . . . for controlled flow and controlled pressure distribution in the mold cavity.
- Styron 777 . . . for medium-impact strength.
- Styron 475 . . . for high-impact strength and high elongation.
- Styron 475 sheet . . . for vacuum or pressure forming.
- Styron 480 . . . for extra-high-impact strength.
- Styron 700 . . . for high heat resistance.
- Styron 637 . . . for improved light stability.

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upholstery, and window screening, the new formulation is expected to be used for such new markets as awnings and venetian blind tapes.

The new formulation offers greatly improved light stability, controlled shrinkage, reduction of static, and good extrudability. The resin retains other features, including toughness, resistance to mildew or stain, and can be easily cleaned.

Fabrics woven of the improved saran show several times the light stability of former saran woven products.

EXPANSION

Monsanto Chemical Co.'s Plastics Div. announces that the company will double its facilities for production of vinyl chloride polymers and copolymers at the Springfield, Mass., plant. Construction has begun and initial resin production is scheduled for early 1956.

Bestway Products, Inc. has opened its new plant on Globe Ave., Mountainside, N. J. The company, organized in 1945 by Al Massler and James Wilson, is a pioneer producer of injection molded thermoplastic phonograph records. Bestway's low-priced records are distributed by Simon & Schuster and Pocketbooks.

More than 300,000 records a day can be produced in the new plant. The injection equipment, especially designed for this purpose, can also be used for other plastics products such as kitchenware and other household items, toys, and industrial parts.

Worcester Moulded Plastics Co. has purchased 20,000 sq. ft. of floor space, located directly across the street from its present plant in Worcester, Mass. The newly acquired property will be used for warehousing and storage purposes.

Sommers Plastic Products Co., 7-9 W. 18th St., New York 11, N. Y., has acquired additional office and warehouse space at 3-5 W. 18th St., comprising a combined total of about 25,000 sq. ft. of floor space. The company has also expanded its office and warehouse at 832 W. 11th St., Los Angeles, Calif., which are headed by **Martin Albert.**

Sommers recently formed a Canadian subsidiary, **Sommers Plastics of Canada, Ltd.,** 6333 St. Lawrence Blvd., Montreal, Que. **Phil Schechter** is manager of the subsidiary.

Acar Broach Co., supplier of precision broaches for the automotive and general metalworking fields, announces the opening of a new plant to fabricate metal dies and molds for shaping plastics parts.

The new organization, incorporated under the name of **Acar Die & Mold Engineering Co.,** is located in Detroit's suburb of Roseville, Mich. The new plant includes complete engineering facilities and will specialize in fabricating large compression molds used in forming such items as auto heater bodies, air-conditioning housings, and similar units made of plastics.

Boonton Molding Co., Boonton, N. J., has established a **Special Products Div.,** which will offer a wide variety of products and services. The company has been engaged in custom compression and injection molding of plastics since 1921, in addition to producing its line of melamine tableware, known as Boontonware.

The new division has facilities for the manufacture of plastics products using such materials as epoxy and polyester resins, polyvinyl plastisols, foamed plastics of all types, Kel-F, and silicone molding compounds.

Services available on a contract basis include an assembly department handling electrical assembly and testing connected with the potting of electronic components and assemblies.

COMPANY NOTES

Acheson Dispersed Pigments (Texas) Co. has opened a new plant in Orange, Texas, to supply polyethylene producers with dispersions of pigments and carbon black. The plant is a corporate subsidiary of **Acheson Industries, Inc.** and is an extension of an operation already well founded under the name **Acheson Dispersed Pigments Co.,** 2250 E. Ontario St., Philadelphia 34, Pa. It is the fourth unit of the parent company, which also includes **Acheson Colloids, Ltd., Slough, England.**

The Dow Chemical Co., Midland, Mich., announces the following appointments: **Dr. J. L. McCurdy,** formerly manager of the Torrance, Calif., plant, has been promoted to assistant manager of the production department in Midland. He will be in charge of Styron, saran, Ethocel, vinyltoluene, and polyvinyl chloride operations. **Daniel W. Ryan,** formerly production superintendent, succeeds Dr. McCurdy as manager of the Torrance plant. **Louis E. Tallman** has been named head of the Western section of Plastics Technical Service, Los Angeles, and will be assisted by **Orwin G. Maxson.** Mr. Tallman has been handling PTS work on injection molding and will now also assume similar activities in connection with plastic films, foam, sheet, and extrusions. Mr. Maxson will handle plastics extrusion and molding technical service. **E. E. (Mike) Merrill** has been appointed to a new post as head of the Eastern section of Plastics Technical Service and will handle plastics development and customer service in the New England area. He will make his headquarters at the Allyn's Point, Conn., plant where Styron and Styrofoam are manufactured.

General Electric Co., Pittsfield, Mass., announces that **Theodore C. Ohart** has been named manager of marketing of the Silicone Products Dept. and **Dr. A. Eugene Schubert** manager of engineering of the Chemical Materials Dept.

Monsanto Chemical Co.'s Plastics Div., Springfield, Mass. has established an Industrial Applications Dept., with **Thomas A. DeMarco** as manager. The department will aid end-users in the accurate specification of plastics materials. Another function will be to determine in what directions Monsanto can expand its product line to supply demands which now are being supplied inadequately or not at all.

The company also announces that **Edward R. Tolles** has been appointed sales manager of the Ultron Vinyl Film and Sheeting Dept. **Howard S. Bergen, Jr.,** technical sales

At This Moment...

all other Plastic Presses are old fashioned

The first completely new *AUTOMATIC* press
for the Plastics Industry in years

with • highest 400″ per minute range closing speed.
• highest speed cycle time.
• material feeds.

PLUS LEASING ARRANGEMENTS

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DESIGNED AND ENGINEERED BY THE MANUFACTURERS OF MACHINE TOOLS SINCE 1875

WRITE PLASTIC PRESS DIVISION
BAKER BROTHERS INC., 1010 POST ST., TOLEDO 10, OHIO

4 EASY STEPS TO BETTER PRODUCTION HEAT

1 Call in

the experienced Chromalox Electric Heating Specialist serving your area. He's as near as your phone.

2 Talk over

your heating plans and problems. You'll be given "case histories" of successful applications similar to your own.

3 Work out

the details of your application with the Chromalox Heating Specialist. Tell him what you want to accomplish in the way of results.

4 Follow Through

on the recommendations. Order the Chromalox Electric Heaters and controls needed for your application. You'll be more than pleased with the time, money and material saving results you'll get with Chromalox Electric Heat!

At Your Service

A STAFF OF EXPERIENCED APPLICATION ENGINEERS

SEND FOR "101 WAYS" HANDBOOK and address of Chromalox Engineer serving you.

A-4431

EDWIN L. WIEGAND CO., Industrial Division
7503 Thomas Blvd., Pittsburgh 8, Pa.

☐ Send me 101 Ways to Apply Electric Heat handbook.

☐ Have a Chromalox Heating Specialist call

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Company.....

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City.....Zone.....

State.....

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ELECTRIC HEAT
FOR MODERN INDUSTRY

THE PLASTISCOPE

specialist on plasticizers in Monsanto's Organic Chemicals Div. at St. Louis, has been transferred to the company's Los Angeles, Calif., district sales office.

O. E. Norberg, formerly director of appliance engineering of Crosley and Bendix Home Appliances, has formed his own company, **O. E. Norberg & Associates**, Roselawn Center Bldg., Section and Reading Rds., Cincinnati, Ohio. The company will act as consultant on product design and also serve several manufacturers as sales representative.

Heresite & Chemical Co., Manitowoc, Wis., announces that **I. L. Place**, vice president of the company, will also assume the duties of general manager. **Robert Riha** has been named sales manager.

The Rex Corp., West Acton, Mass., announces the appointment of **Howard E. Pendergast** as assistant general manager of the company and **Harold E. Prouty** as assistant treasurer and controller. Mr. Pendergast was formerly assistant general manager of the firm's West Coast territory.

Celanese Corp. of America's Plastics Div., 180 Madison Ave., New York 16, N. Y., announces the addition of five new members to the Market Development Dept. as follows: **Kevin Bradley**, formerly associated with Interchemical Corp., has joined the market research section; **William G. West** will specialize in resin marketing; **Howard S. Malby** will concentrate on resin development in the West Coast area; and **Stan Kadin** and **Tom Welsh** have joined the technical service and application research section at the Linden, N. J., polyester resin plant.

J. B. Henriques, Inc., 521 Fifth Ave., New York 17, N. Y., exclusive distributors in the United States of Perspex acrylic resin sheets, manufactured in England by the **Plastics Div., Imperial Chemical Industries, Ltd.**, has appointed **M. Melvin Sirota**, Los Angeles, Calif., as its manufacturer's representative and sales agent on the West Coast.

Dr. Rene G. Smoller, P. O. Box 405, Long Beach, N. Y., has been named United States representative

Cost-Cutting Ideas

Can proper labeling help cut plastics production and distribution costs to any appreciable degree? When you figure that a 4% savings on costs often represents as much in profit as a 20% increase in sales, the answer is a resounding *yes*. Many plastics manufacturers, processors and merchandisers report substantial savings that give them a valuable competitive edge.

Ease the Squeeze on Profits—Just think how Ever Ready labels can help *you* save time, labor and materials in every phase of *your* operation . . . from receiving platform right through all the steps of production, inspection, inventory control, packaging, advertising, merchandising and servicing. What's more, Ever Ready labels help you reduce damage, delay and loss in your warehousing and shipping. They sway buyers at the critical moment of decision. They make friends for you *after* the sale by advising proper use and maintenance of your product.

The Key Factor—If your product is sold on a self-service basis, your best assurance of merchandising success is a package with impulse-buying appeal . . . a label with built-in impulse-impact. This requires the most skillful use of design, color, copy, typography . . . and the advice of label specialists. That's why so many plastics firms call on us to help develop special labels for brand building, price changing, special offers, dealer aids, etc. For Ever Ready labels lure, urge, tell, sell . . . stir all the human emotions . . . at a remarkably low cost per stir.

Free Design Service—Whether your product is in the dream, design or distribution stage, our consultants will help you and your agency develop a *planned labeling program* . . . labels of any size, shape, color or adhesive . . . for any surface, purpose or product. Our Red•E•Stik pressure-sensitive line was specially developed to give production-line speed on hard-to-label surfaces.

To see just how much proper labeling can save *you*, send for samples, case histories and this *free* literature:
Red•E•Stik 'Test - It - Yourself' Kit
Ever Ready Plastics Labeling Ideas
Building a Label with Impulse-Impact

Plastics Division

Ever Ready Label Corporation

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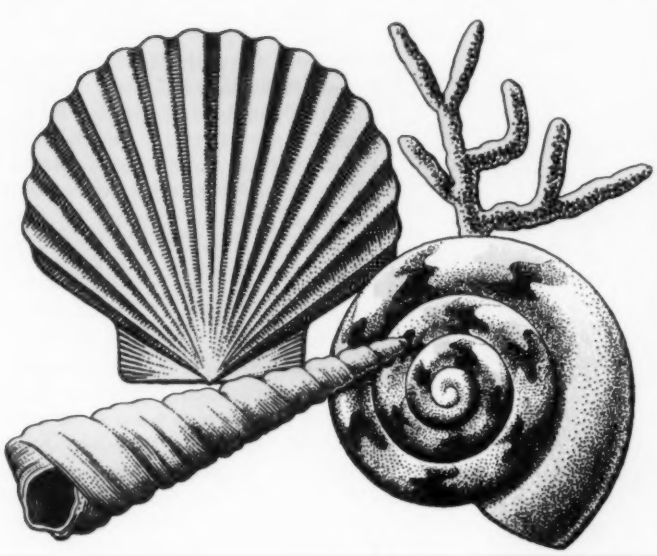
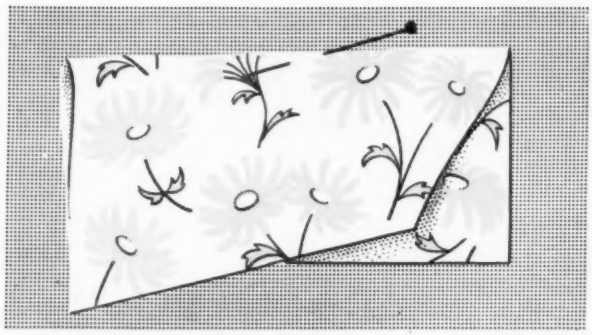
MU 6-1220 Plant: Belleville 9, N.J.

Why does man use color





DECORATION FOR HOME FURNISHINGS

Bright, gay, attractive—these are adjectives for colors—pigments—performing their decorative function. Plastic printers apply appealing patterns to shower curtains, tablecloths and other items for the home with plastic-based inks. For this purpose, Acheson supplies an exceptionally fine group of fast vinyl roto inks in black, white and ten colors.

Colored plastic film and sheeting is obtained by incorporating pigments into the resin before calendering or extruding. Acheson provides predispersed color for trouble-free fabrication.

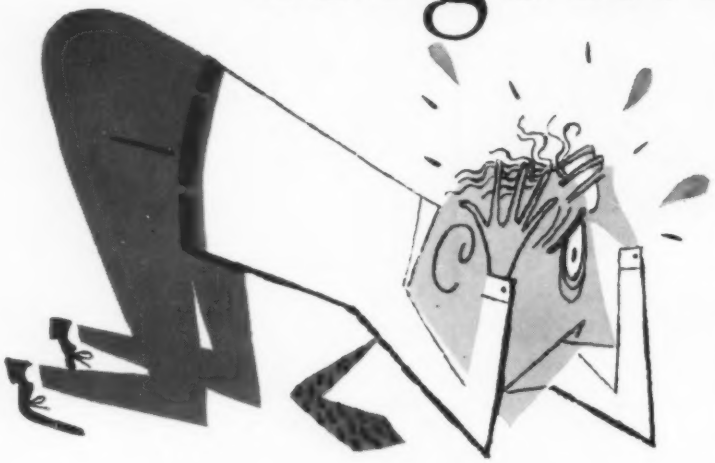
Acheson Dispersed Pigments Co., 2250 E. Ontario St., Philadelphia 34, Pa.
West Coast Distributor: The B. E. Dougherty Co., Los Angeles 21, Calif.
In Europe: Acheson Colloids Limited, Slough, England

ACHESON DISPERSED PIGMENTS CO.

a unit of Acheson Industries, Inc.

DISPERSIONS FOR THE PLASTICS AND PRINTING INKS INDUSTRIES

Dudley forgot...



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It's a wise molder who knows his resources. Ampacet gives you the finest crystal clear cellulose acetate as well as the whitest pearl. Ampacet Polystyrene mother of pearl is ideal for wall tile, cosmetic packaging, jewelry boxes and hundreds of other products. And you'll notice Ampacet Confetti Tinsels, both Cellulose Acetate and Polystyrene, used for the best selling novelties on the market today. There are thousands of applications for Ampacet molding powders. Pearls, Tinsels, Phosphorescents, Iridescents . . . you'll find exactly what you've been looking for. Let us send you full details and samples.

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THE PLASTISCOPE

of **Sofrex S.A.**, Monte Carlo, Monaco; and **Seric S.A.**, Vichy, France. These corporations, through their facilities in France, Monaco, Switzerland, Italy, Portugal, and the Benelux countries, manufacture, promote, sell, and distribute domestic and foreign plastics products, as well as conduct research on new plastics in their French territories. They also manufacture molds for local and foreign markets.

Filon Plastics Corp., 2051 E. Maple St., El Segundo, Calif., formerly known as Plexolite Corp., has established a midwestern sales office at 228 N. LaSalle St., Chicago, Ill., headed by **Gustav Morner.** The creation of the new office is part of Filon's program to exploit its newly developed fibrous glass and nylon reinforced panel.

Tru-Scale, Inc., 1123 N. Mosley St., Wichita, Kans., has made the following appointments to its board of directors: **Dr. Hal G. Johnson,** director of the General Development Dept., Research and Engineering Div., **Monsanto Chemical Co.,** St. Louis, Mo.; and **Dr. Johan Bjorksten,** president of **Bjorksten Research Laboratories,** Madison, Wis.

Tru-Scale, supplier of impregnated glass cloth for engineering drawings and photo reproduction, claims to have designed and built the largest reinforced plastic draw die ever constructed.

B.I.P. Engineering, Ltd., Div. of British Industrial Plastics, Ltd., England, has named **Williams Co.**, Providence, R. I., to handle its advertising and sales promotion in the United States through its American representative, **Ralph B. Symons Associates, Inc.**, Tiverton, R. I.

B.I.P. Engineering, manufacturer of hydraulic pelleters and compression-transfer presses, will promote its products through trade papers and by direct mail.

M. Wintrob & Sons Canada, Ltd., Toronto, Ont., has acquired **The French Ivory Products Co., Ltd.**, a thermoplastics molder and fabricator in Canada. French Ivory Products, principally a custom molder, is located on the outskirts of Toronto. This plant will also house the opera-

tions of **Plasti-Pak Containers, Ltd.,** another Wintrob associated company which manufactures a variety of plastic boxes and containers for the food industry.

Beech-Nut Packing Co. announces the appointment of **Sheffield Chemical Co., Inc.,** Norwich, N. Y., Div. of National Dairy Products Corp., as its sales agent for Beech-Nut polyvinyl acetate resins.

Mobay Chemical Co., St. Louis 4, Mo., has granted two licenses to **Albert Trostel & Sons Co., Inc.,** Milwaukee, Wis., tanner of side upper leathers, for the manufacture of polyurethane rubber materials and polyurethane rigid and flexible foams.

A subsidiary, **Albert Trostel Packings, Ltd.,** Lake Geneva, Wis., manufactures hydraulic and pneumatic seals for the automotive, farm implement, and aviation industries.

The company also announces the appointment of **Charles O. Koch** as technical service superintendent and **Richard F. Cassidy** as production superintendent of Mobay's new isocyanate plant in New Martinsville, W. Va.

Stahl Finish Co., 26 Howley St., Peabody, Mass., reports that **Max Potash** has been named manager of its newly formed Poylvinyl Chemicals Div. and **Harold Naidus** director of development and sales. Both appointees were formerly associated with American Polymer Co., Chemical Div. of The Borden Co., as chief engineer and research director, respectively.

The company states that the new division was organized to expand the parent company's activities in the manufacture of synthetic polymer emulsions and solutions for the leather, paint, adhesives, paper, and textile industries.

Davis-Standard Sales Corp., Mystic, Conn., has granted a license to **Finney Presses, Ltd.,** Birmingham, England, to manufacture and market Davis-Standard electrical wire insulating machinery in Europe and the Sterling Area.

Transparent Products Corp., 1739 W. Pico Blvd., Los Angeles 15, Calif., distributor of plastics film and sheeting, has named **Harry O. Hill** sales manager of the company. Mr. Hill was formerly affiliated with Celanese

"...and to Charlie, my favorite nephew, I bequeath all my **plastics scrap**— worth a fortune at A. Bamberger's."

Uncle Phisby knew that plastic scrap is worth a sock full of cash at A. Bamberger's. Somewhere in *your* plant you have the same kind of treasure . . . surplus virgin inventory, off-color molding powder, obsolete parts . . . scrap that's idling and eating up space. Turn it into cash. Call us in. Write, phone or wire. Send samples, or let us inspect. You'll get top prices. And want to save money on purchasing? Try us for reprocessed and virgin plastics of guaranteed quality.

CELLULOSE ACETATE • BUTYRATE • POLYSTYRENE POLYETHYLENE • METHYL METHACRYLATE • VINYL • ETHYL CELLULOSE • NYLON • ACRYLONITRILE • CRYSTAL CLEAR PURGING COMPOUND FOR INJECTION MOLDERS

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Detroit MACOID

* MACOID produces a variety of anti-squeak trim moldings for automobile interiors which were designed and engineered in cooperation with leading automobile manufacturers.

Producing intricate injection molded trim for automobile interiors is only one of MACOID'S many specialties.

Whatever the product—if it can be made of thermoplastics there's a team of MACOID specialists ready to step in and do the job quickly, efficiently at *any* stage of development!

If you'd like, MACOID stylists can translate your rough sketch into a practical, finished design. Or MACOID'S engineering staff can convert your product specifications into working drawings.

And—MACOID is equipped to maintain *quality standards* at the lowest possible per-unit cost. MACOID'S extrusion and injection molding facilities are among the most efficient in the industry.

For a way to do it better with plastics—consult Detroit MACOID.

DETROIT MACOID CORPORATION

12340 CLOVERDALE, DETROIT 4, MICHIGAN

EXTRUSION AND INJECTION MOLDING

Originators of Dry Process Plastics Extrusion

THE PLASTISCOPE

Corp. of America's Plastics Div., and has been active in the plastics industry since 1938.

Baker Brothers, Inc. announces that **Norman W. Oberle** has been appointed merchandising manager and **John Hoenig** manager of the die cushion and plastic press department located in the former Nash Mfg. Building, 138-142 Sylvania Ave., Toledo, Ohio.

The company is now prepared to present a complete line of fully automatic machines ranging from 15 to over 100 tons. The presses are available with new powder feeders, plastic rope feeders, loader boards, and other press accessories.

Argus Chemical Corp., 633 Court St. Brooklyn 31, N. Y., has opened an office at 2063 E. 4th St., Cleveland, Ohio, under the direction of **Richard N. Derr.** He was formerly affiliated with Firestone Plastics Co.

PERSONAL

Ralph C. Krueger has been named an assistant manager of industrial sales of **Du Pont's Film Dept.**, a new position created as a result of increasing volume of business in the industrial field. Mr. Krueger's activities will supplement those of **William B. Davis**, who has been assistant manager of industrial sales since 1952.

Sol Sackel has resigned as director of advertising and merchandising of **Bolta Products, Div. of The General Tire & Rubber Co.**, Lawrence, Mass. Mr. Sackel will form a new advertising agency, The Sackel Co., Inc., Boston, Mass.

Franklin Farrell 3rd has been elected president of **Farrell-Birmingham, Inc.** Ansonia, Conn. He succeeds Franklin R. Hoadley, who has retired. Mr. Farrell is the fourth generation of his family to be actively connected with the company.

Dr. Leopold Eckler has been elected vice president of **General Aniline & Film Corp.**, 230 Park Ave., New York, N. Y., and general manager of the company's Ansco Div. Dr. Eckler, who has been general manager of Celanese Corp. of America's Plastics Div., returns to Gen-

Tailor-Made ADHESIVES

from Thiokol® Liquid Polymers and Liquid Epoxies

Built-in flexibility is imparted to epoxy adhesives by combination of "Thiokol" Liquid Polymers with Liquid Epoxies. Properties can be tailor-made for specific applications by varying the amount of "Thiokol" Liquid Polymer in the combination.

These combinations have resulted in a wide extension of the utility of epoxy-based adhesives. By themselves, epoxy-based adhesives display excellent adhesion to many materials, but are too brittle for many applications. They lack peel, impact and bend resistance. These defects are overcome by incorporating flexibility with "Thiokol" Liquid Polymers. The following typical improvements result:

HIGH PEEL, BEND AND IMPACT STRENGTH • PERMANENT FLEXIBILITY OVER A BROAD TEMPERATURE RANGE
HIGH SHEAR STRENGTHS WITH ROOM TEMPERATURE CURES • IMPROVED RESISTANCE TO MANY SOLVENTS
LOWER SHRINKAGE ON CURING • FLUID MIXES WITHOUT RESORT TO SOLVENTS

"Thiokol" Liquid Polymer/Epoxy adhesives are versatile. They are excellent adhesives for plastics, fibers, leather, rubber, aluminum, steel, copper, tin, zinc, wood, glass and ceramics.

An aluminum honeycomb structure bonded with a "Thiokol" Liquid Polymer/Epoxy adhesive is shown in the illustration. Other recent applications include bonding fiber glass structures . . . adhering fiber glass laminates to wood and ceramics . . . and bonding rubber to zinc-plated steel.

For complete information on the properties of these adhesives, write:

The potentialities of "Thiokol" Liquid Polymer/Epoxy Resin adhesives have not yet been fully exploited. Aside from their ability to solve difficult adhesive problems, they offer the possibility of simplifying fabrication methods.

Thiokol
Chemical Corporation

SYNTHETIC RUBBERS • PLASTICIZERS • CHEMICALS • SOLID PROPELLANTS

784 NORTH CLINTON AVE., TRENTON 7, N. J.
In Canada: Naugatuck Chemicals Division,
Dominion Rubber Company, Elmira, Ontario

FULLY AUTOMATIC ELECTRO-MECHANICAL DRIVE
for all models HENDRICK PANEL SAWS

and available also as supplement equipment for all manual models now in the field.

ELECTRO-MECHANICAL DRIVE
COMPLETE $450.00

(This figure does not include the Panel Saw or the Saw motor. Prices of these are found in the general catalog of manually-operated HENDRICK PANEL SAWS.)

OPERATION: Thru full complement of General Electric Controls comprising magnetic reversing switch with manual disconnect—adjustable limit switches on rails—Remote 5-station push button governs forward reverse, stop for saw carriage and start-stop for saw motor—Magnetic Starter with interlock for saw motor. Fixed gear motor activates saw carriage only when saw motor circuit is closed. At completion of cut limit switch automatically steps saw and carriage and returns it to starting position—Can be set to cut in both directions if desired.

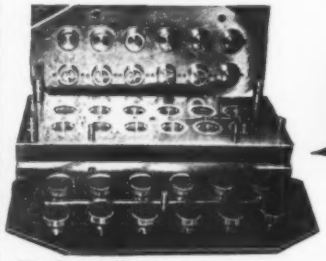
GEAR MOTORS: The automatic reversing gear motors are 1/15 H.P., 110 V, 60 cycle, capacitor type, and are available in three models, each to produce fixed saw carriage travel speeds of 20, 30 and 60 feet per minute. The minimum torque is 30 inch pounds. A wider travel speed range is available in other gear motors which are not required to reverse automatically.

VARIABLE SPEED DRIVE: All models of MLR Panel Saws may be equipped with a VARIABLE SPEED DRIVE in ¼ H.P. single or three phase, to produce any selected carriage travel speed between 0 and 70 feet per minute. PRICE: $240.00 additive to total.

HENDRICK MFG. CORP., Marblehead, Mass.

SAVE TIME AND MONEY!
SEE YOUR PRODUCT BEFORE MAKING THE MOLD

We Create
PRE-MOLD MODELS
From Your Ideas or Designs



and Follow Through with Quality-Tested
PRODUCTION MOLDS
to the Finished Product

We Specialize in
INJECTION
COMPRESSION
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Check Cavity Temperatures

Combination and Single Purpose Instruments

In molding plastics, the routine use of the Cambridge Mold Pyrometer will go a long way in preventing off-colors, brittleness, soft centers and low tensile strength. This Pyrometer is an accurate, rugged instrument that instantly indicates the surface temperature of mold cavities.

Send for bulletin 194—S

CAMBRIDGE INSTRUMENT CO., INC.
3711 Grand Central Terminal, New York 17, N. Y.

CAMBRIDGE
MOLD • NEEDLE • ROLL
PYROMETERS

Bulletin 194—S gives details of these instruments. They help save money and make better plastics.

eral Aniline after an absence of six years. He was with the Ansco Div. from 1928 to 1948 when he resigned to join Celanese.

Paul C. Panagiotakos is now director of sales of **National Polychemicals, Inc.**, Wilmington, Mass. He was formerly chief chemist of New England Tape Co., Inc.

Mark Pinkerman, advertising manager of **Reichhold Chemicals, Inc.**, 525 North Broadway, White Plains, N. Y., has been named vice president of advertising and public relations.

Herbert D. Stuber, formerly superintendent of **The Dow Chemical Co.'s Saran Rubber Dept.,** has opened an office at 5416 N. College Ave., Indianapolis, Ind., to represent **Saran Lined Pipe Co.,** Ferndale, Mich., in several states.

Succeeding Mr. Stuber as superintendent in the Dow Saran Rubber Dept., is **Cyrus C. Perkins,** who joined Dow in 1946 and has served as an engineering draftsman in the saran polymerization laboratory and as a development engineer.

David H. Simonds has been named director of advertising of **Bolta Products, Div. of The General Tire & Rubber Co.,** Lawrence, Mass.

Walter S. Krusich is now sales manager of **Campro Sales Co.,** Canton, Ohio. The company is a custom molder of plastics and also manufactures Jiffy cabinets for small parts storage, as well as other items in the stationery, housewares, and industrial lines.

Milt K. Grey, who recently resigned as vice president of Revell, Inc., Venice, Calif., has been elected vice president and merchandising director of **Transparent Shade Co.,** 501 N. Figueroa St., Los Angeles, Calif.

Charles F. Beckman has been appointed vice president in charge of sales of **Polymold Plastics, Inc.,** 3417 N. Western Ave., Chicago 18, Ill. Mr. Beckman was formerly engaged in engineering and sales at General American Transportation Corp.'s Plastics Div.

S. Ernest Kulp, director of market research of **Masland Duraleather**

We want to make it

CLEAR!

Clear vinyl garden hose that stays clear! The quickest way to lose a customer is to charge a premium price for a clear hose which turns opaque in use.

To guard against this, the stabilizer must remain in the hose and not be leached out by water. Advance ADVASTAB 52 has the longest and best outdoor exposure record of all clear vinyl hose stabilizers. It's the standard of the industry.

FOR ECONOMY — NEW ADVASTAB 48-79

A new exceptional cadmium compound developed specifically to meet the demand for a low cost stabilizer for clear hose, ADVASTAB 48-79 exhibits none of the deficiencies usually found in cadmium stabilizers. It was found to have the least water absorption of all cadmium stabilizers tested. All other types tested showed water pick-up in from 3 to 72 hours causing the hose to turn milky — no longer a quality clear hose but an opaque. Advance's new ADVASTAB 48-79 has also been found to have outstanding heat and light stability and has withstood extensive outdoor exposure tests.

Write for samples and complete data. Ask too, for a copy of the folder describing all our vinyl stabilizers.

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Additive Chemicals for the Process Industries

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Plaskolite, Incorporated, specializes in precision workmanship, rugged construction . . . for plastic extrusions that meet exacting specifications. If you need sturdy extrusions, soundly engineered, feel free to consult us . . . as so many companies have. Our staff engineers welcome special design or production problems.

- Producers of lighting shields.
- Sheeting for vacuum forming and other applications.
- Experienced in making difficult profiles.
- Equipped to manufacture large sections.

Write For Information, Suggestions and Price Quotations.

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(Inorganic & Organic)
FOR
Quality paints
Shawnee DRY COLORS
- BRILLIANT
- EASY GRINDING
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- PERMANENT

Kentucky Color
AND CHEMICAL COMPANY, INC.
General Office and Works
LOUISVILLE, KENTUCKY
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42,293 ADVERTISEMENTS
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Your Where-to-Buy Encyclopedia

Thomas Publishing Company
461 Eighth Avenue, New York 1

Co., Philadelphia, Pa., has been re-elected president of the **Plastic Coatings and Film Association**, 9 Rockefeller Plaza, New York 20, N. Y.

Deceased

Lawrence W. Seybold, retired vice president and treasurer of **Michigan Molded Plastics, Inc.**, Dexter, Mich., died at the age of 61. Mr. Seybold, a pioneer in the plastics industry, spent 36 years of his life in the development and production of plastics. He originally started his career with Reynolds Molded Plastics Div., Reynolds Spring Co., Jackson, Mich., and in 1940 became an associate of Michigan Molded Plastics.

MEETINGS

May 1-4—American Institute of Chemical Engineers, Meeting, Shamrock Hotel, Houston, Texas.

May 7-15—The Society of the Plastics Industry, Inc., 1955 Annual Conference, Convention Cruise aboard *Queen of Bermuda* to Havana, Cuba, and Nassau, B.W.I.

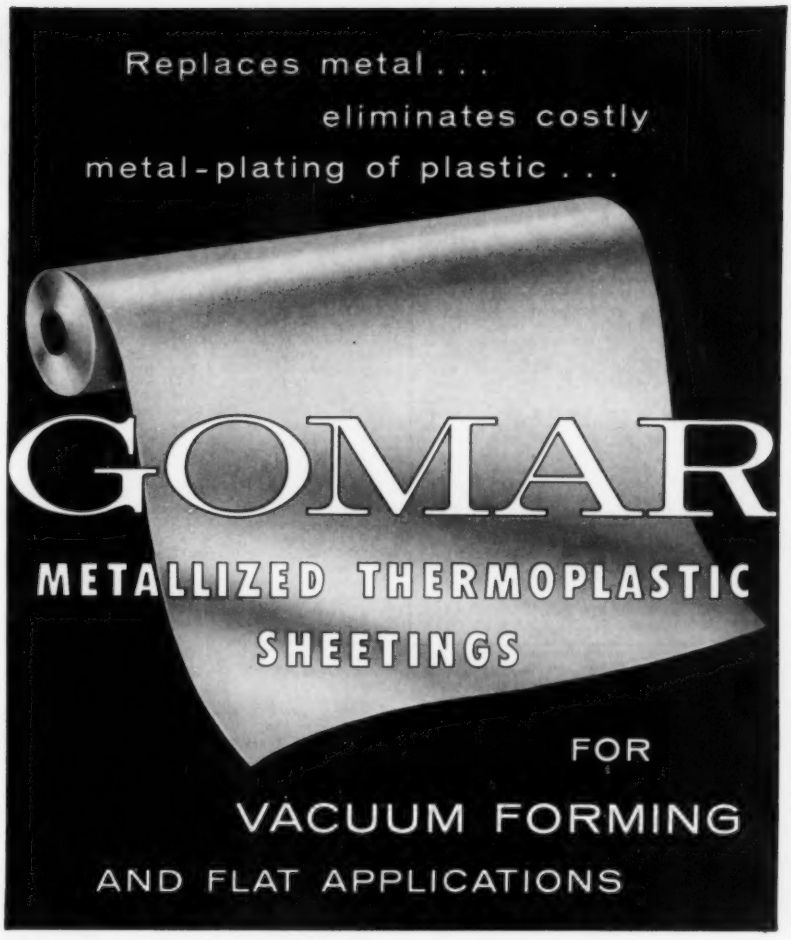
May 14-22—ACHEMA XI, Chemical Plant and Apparatus Exhibition and Congress, Frankfurt am Main, Germany. Sponsored by Deutsche Gesellschaft für Chemisches Apparatewessen (DECHEMA). Additional information may be obtained from the Chicago Section of the American Chemical Society, 86 E. Randolph St., Chicago, Ill.

May 18-19—The Chemical Market Research Association, Annual Meeting, Hotel Plaza, New York, N. Y.

June 1-11—British Plastics Federation, British Plastics Convention and Exhibition, National Hall, Olympia, London, England. Applications for tickets should be made to British Plastics Exhibition, Associated Iliffe Press, Dorset House, Stamford St., London S.E. 1, England, stating for which sessions they are required.

June 2-3—Institute of Radio Engineers, Materials Symposium, The University of Pennsylvania, Physics Building, Room A1, Philadelphia, Pa.

June 26-July 1—American Society for Testing Materials, Fifty-eighth Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.



Everywhere . . . manufacturers are turning to Gomar Metallized Thermoplastic Sheeting to make better-looking, *far less expensive* radio speaker grilles, trademark plaques, trim for electrical appliances, toys and toy parts, displays, costume jewelry, ornaments, packaging and novelties. Yes! They're using the versatile new plastic that looks just like metal—to take the place of metal, or eliminate costly metal-plating of plastic.

Gomar Butyrate, for deep-draw vacuum forming; and Gomar Acetate for shallow-draw forming and flat applications. In 18 brilliant metallic colors, and in transparent, chalk and iridescent colors, smooth or embossed. Can be scored, pleated, glued, imprinted, etc.

We'll be happy to send you samples, literature, color chart. Simply write or phone.

GOMAR

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MACHINERY and EQUIPMENT FOR SALE

AVAILABLE AT BARGAIN PRICES
Mitts & Merrill 15CD Rotary Cutter. J. H. Day, from ¾ up to 100 gal., Imperial and Cincinnatus D.A. Jacketed, Sigma Blade Mixers. Day 15 to 10,000 lbs. Dry Powder Mixers. Baker Perkins Heavy Duty Steam Jacketed, Double Arm, from 5 to 200 gal., Mixers (Unidor and Vacuum also). Gemco 2000 lb. 56 cu. ft. Double Cone Blender. Mikro Bantam 1SH, 2TH, 3W, 4TH Pulverizers, Rotex, Tyler Hum-mer, Robinson, Raymond, Gayco, Great Western Sifters. Colton 2 RP and 3 RP Rotary & #5½ Tablet Machines. Carver Laboratory 20 ton Hydraulic Press. Package Machy. FA, FA2, FA4, U4, Miller, Hayssen, Wrap-King, Scandia, Oliver Auto. Wrappers—all sizes. This is only a partial list. Over 5000 machines in stock available for immediate delivery. Tell us your machinery requirements.
UNION STANDARD EQUIPMENT CO.
318-322 Lafayette St., New York 12, N.Y.

FOR SALE: 1—F.B. 32"x92" inverted-L 4 Roll Calender, reduction drive, d.c. vari-speed motor; 1—Royle #4 Extruder, motor driven; 1—6"x12" Laboratory Mill, m.d. 1—Farrell-Birmingham 6"x13" 3 Roll Calender; 1—Ball & Jewell Rotary Cutter, Model 251, m.d.; 2—Baker-Perkins Size 15, 100 gal. Jacketed Mixers; 5—Horizontal Dry Powder ribbon Mixers, 4000#, 1500#, 500#; 1—New 3 Roll 6"x16" Laboratory Calender; 1—Farrell-Birmingham 60" Mill with reduction drive, 150 HP motor, floor level mounting; 1—Fitzpatrick "D" Comminutor, S.S. contact parts, jacketed; 1—Mikro Pulverizer #2th, with motor; 4—Reed Prentice & W-S Injection Molding Machines, 2-16 oz.; 4-Hymac 125 ton Molding Presses, 16"x16" electrically heated platens. Also other sizes: Hydraulic Presses, Tubers, Banbury Mixers, Mills, Vulcanizers, Calenders, Pellet Presses, Cutters. Send us your inquiries. What have you for sale? CONSOLIDATED PRODUCTS CO., INC., 50 Bloomfield Street, Hoboken, N.J. HOboken 3-4425. N. Y. Tel. BArclay 7-0600.

FOR SALE: 3—National 10"x20", 6"x14" Two Roll Mills; 1—Baker Perkins 100 gal. S.S. double arm, jacketed Vacuum Mixer; 3—Baker Perkins 100 gal., 50 gal. jacketed double arm Mixers; 2—Stokes Rotary Preform Presses DD2, D3; 1—Stokes Model "R" single punch Preform Press; 1—Kux Model 15-25 double action Rotary Press; 2—Cumberland #0 Rotary Cutters; Also: Sifters, Cutters, Banbury Mixers, etc., partial listing; write for details we purchase your surplus equipment; BRILL EQUIPMENT CO., 2407 Third Ave., New York 51, N. Y.

FOR SALE: New imported extruders. Latest developments, self contained. Moderately priced. For details write or call: ACME MACHINERY & MANUFACTURING CO., 102 Grove Street, Worcester, Massachusetts. Phone: PLeasant 7-7747.

FOR SALE—INJECTION MOLDING MACHINES. One Lester 12½-12 oz. (Ser. #466), new 1948, used only ½ of time; adapted for molding nylon. One Lester L-2½-8 oz. (Ser. #396), new 1949, used very little. Both machines in good condition. Can be seen molding clear acrylic automotive parts. Spare heaters, plungers, feed cylinders at reduced prices. Located Mich. Reply Box 50255, Modern Plastics.

FOR SALE: Hobbing Press 800 Ton W.S. (2) 300 Ton W.S. Presses 20x20 & 29x24 Platens. 140 Ton W.S. 22x16 Platen. 85 Ton Waterbury Farrel 20x24 Platen. 63 Ton Press 15x15 Platen with Pullback Cyls. 9, 8, 4, Oz. Injection Molding Machines. 15 Ton Lab. Presses 10x8 Platen. 10 Ton Lab. Presses 6x6 Platen Ball & Jewell Plastic Grinders. Standard Mystic Embossing Presses, Accumulators, Pumps, Valves. Many other Presses—Send For Bulletin. AARON MACHINERY CO., INC., 45 Crosby St., New York 12, N. Y. Tel. WAlker 5-8300.

FOR SALE: 60 oz. H.P.M. 48 oz. Lester, $45,000. 40 oz. H.P.M., $28,000. 32 oz. Lester, 1950, $22,000. 32 oz. Reed-Prentice, 1950, $26,000. 22 oz. Reed-Prentice, 1947, w/plunger advance, $13,500. 22 oz. Reed-Prentice, 1945, excel., $11,000. 16 oz. H.P.M., $9,500. 16 oz. Watson-Stillman, $16,500. 12 oz. Reed-Prentice, 1950, $10,500. 12 oz. Lester, $5,000. 12 oz. Watson-Stillman, 1948, $10,000. 8 oz. Reed-Prentice, 1946, $6,500. 8 oz. DeMattia, $4,500. 8 oz. Lester 2½L, $5,500. 8 oz. Reed-Prentice w/10 oz. cyl., $8,500. 8 oz. Leominster, $5,000. 6 oz. Reed-Prentice, $3,500. 6 oz. Lester, $4,000. 6 oz. DeMattia, $3,250. 6 oz. Heisgen, $2,500. 4 oz. H.P.M., $3,350. 4 oz. Reed-Prentice, 1948, $5,200. 4 oz. Impco, $6,850. 4 oz. Lester, $3,000. 4 oz. Lester, Vertical, $4,500. 3 oz. Fellows, $6,500. 2 oz. Dowding & Doll, $3,350. 2 oz. Reed-Prentice, $1,350. 2 oz. DeMattia vert., $750. 3¼" Hartig extruder, $2,500; new powder mixers, $315; 150 ton closure presses; 6 tray oven, $150; 80 ton transfer & compression press, new, $4,250; #235-A Stokes. ACME MACHINERY & MANUFACTURING CO., 102 Grove Street, Worcester, Mass. Tel: Pleasant 7-7747.

FOR SALE: (11) 75 ton record presses, complete @ $2,450, (11) new 100 ton, 10" ram, 10" stroke @ $1,100, (8) 200 ton, 9" stroke, 14" ram, 36x36 @ $1,850, (7) 200 ton, 9" stroke, 15" ram, 30x30 @ $1,650, (1) 50 ton complete, 18x18 @ $1,850, (1) 200 ton, 16" ram, 30x30 @ $2,450, (2) 200 ton, 16" ram, 42x42 @ $2,850, (1) 200 ton, 15" ram, 42x42 @ $2,450, (4) 250 ton, (2) 12" rams, 30x60 rebuilt @$3,375. HYDRAULIC SAL-PRESS CO., INC., 388 Warren Street, Bklyn, N. Y.

FOR SALE: Blaw-Knox 15 gallon Resin Kettle Pilot Plant, type 347 stainless steel, jacketed and agitated, 150# pressure with Condenser and Receiver, Variable speed drive, Controls, etc. Excellent condition. Also #1½ B & J Stainless Steel Cutter and 2—Kux Model 25 Rotary Presses. PERRY EQUIPMENT CORP., 1429 North 6th Street, Philadelphia 22, Pa.

FOR SALE: Lester L-3-10-16 injection molding machine 16 ounce capacity. Solid frame, spare I. H. plasticizing cylinder. Can be seen in operation. PYRO PLASTICS CORPORATION, 690 Chestnut Street, Union, N. J.

SAVE WITH GUARANTEED REBUILT EQUIPMENT: 2 new R. D. Wood 500 ton embossing presses; 54"x26" platen, HYDRAULIC PRESSES; 40"x54", 36" ram, 1500 tons; 30"x26", 16" ram, 600 tons; 2—27"x27", 16" rams, 585 tons; 20"x20" 10" ram, 200 tons; 20"x20", 14" ram, 200 tons; 15"x15" 8" ram, 75 tons; 14"x14" 8" ram, 75 tons; 2—19"x24" 10" rams 78 tons; 18"x18," 7" ram, 50 tons; 10—26"x26" 7" rams, 50 tons; 12"x12" 7½" ram, 50 tons; 14"x14" 8" ram, 50 tons; 8"x9½" 4½" rams 20 tons; 16"x16" 3½" rams, 12 tons; Carver model 150 and 6"x 6". LABORATORY PRESSES; Stokes Model T, late type with hydraulic equalizer system and drive; Colton 5½T with drive PREFORM PRESSES; NEW UNIVERSAL DUAL PUMPING UNITS 3—15 HP; NEW LABORATORY MILLS and CALENDERS; HPM 6" ram, 2500# pressure ACCUMULATOR; also Extruders, Mixers, Vulcanizers, Injection Molding Units, etc. UNIVERSAL HYDRAULIC MACHINERY COMPANY, INC., 285 Hudson Street, New York 13, N. Y.

FOR SALE: Injection Presses: 4, 8, 12, 16, 24, 32 oz. Reed. 6, 8, 12 oz. Lester; 9, 40 oz. HPM; 1 oz. Van Dorn; 4 oz. Impco; 1 complete Injection plant w.6 press. bldg. vct lot, excell. moneymaker. Extruder conveyors, Scrap grinders, Ovens. Compression & Transfer presses: 50, 100, 250, 600 tons. Preform presses. 25 HP Gas boiler. 42" Slitting & Rewind machine. 1000 t. Elmes Hobbing press. Equipment to be inspected in operation. List your surplus equipment with me. JUSTIN ZENNER, 823 Waveland Ave. Chicago 13, Ill.

FOR SALE: 2—Birdsboro 880 ton self-contained compression presses; 2—Adamson 390 ton compression presses; 1—National Erie 8½" strainer; 2—Stokes Model 294 preform presses, 4" dia.; 1—Ball & Jewell #2 cutter, 40 HP motor; also mills, extruders, mixers, et cetera. CHEMICAL & PROCESS MACHINERY CORP., 148 Grand Street, New York, N. Y.

INJECTION MACHINES FOR SALE: 2, 4, 6, 8, 10, 12, 16, 22, 24, 32, 60 oz. Reed-Prentice; 2, 4, 9, 16, oz. HPM; 4, 8, 12 oz. Lester; 4, 8, 22 oz. Impco; 4, 12 oz. Watson-Stillman; 15 oz. Crown; 16 oz. Munson; 12 oz. DeMattia; 8 oz. Leominster. Reply Box 51955, Modern Plastics.

LEOMINSTER 8 oz. Injection Molding Machine. Plastic and Rubber Equipment. Farrell 16"x48", 15"x36" and 6"x12", 2 roll mills. Mills and Calenders up to 84". New Seco 6"x12" and 6"x16" Lab. Mixing Mills and Calenders. Rubber Plastic Extruders Wat.-Stillman 75 ton automatic Molding Press 20"x20" platens. 200 ton Hobbing Press 18"x14" platens. HPM 200 ton 30"x48" platens. New Loomis 310 ton. 24"x56" platens. 200 ton Brunswick 21"x21" platens, 14" ram. 150 ton Bolling 20"x20" platens. Southwark 30 ton 14"x14" platens. semi-auto. Also Lab to 2000 tons from 12"x12" to 48"x48". Hydr. Oil Pumps. Gould 75 HP motor Dr. 2 stage Centrif. Pump 250#. W.S. 4 Plgr. High and Low Pressure Hydr. Pump. Elmes Hor. 4 Plgr. 4500 lbs. and 5500 lbs. Hydr. Accumulators. Stokes Automatic Molding Presses. Rotary & single Punch Preform Tablet Machines ½" to 4". Injection Molding Machines 1 oz. to 32 oz. Baker Perkins Jacketed Mixers. Plastic Grinders. Heavy duty mixers, gas boilers. Partial listing. We buy your surplus machinery. STEIN EQUIPMENT CO., 107-8th Street, Brooklyn 15, N.Y. STerling 8-1944.

VACUUM FORMING MACHINE (not used over 10 hours) double platen 32x52 inches on both sides Mfg. by the Auto-Vac Company of Fairfield, Connecticut. Price includes Pump & Tank $6,000.00 F.O.B. Franklin Pk. Ill. Call or write: H. M. SCHAEF CORP., 9045-55 W. King St., Franklin Pk., Ill. GLadstone 5-6555.

FOR SALE: Stainless Steel Rotary Dryer, Link Belt Co., 5'2"x16', No. 502-16, with all auxiliary equipment. Roto Louvre type. Reply Box 52755, Modern Plastics.

NEW LINE of by-the-machine grinders with large throat & other special features. Priced very low. For details contact ACME MACHINERY & MFG. CO., 102 Grove St., Worcester, Mass. Tel. Pleasant 7-7747.

FOR SALE: 1—New Hartig Plastic Pelletizing Machine with U. S. Variable Speed Motor—EVERLAST WIRE & CABLE CO., 12 Maple Avenue, Haverstraw, New York.

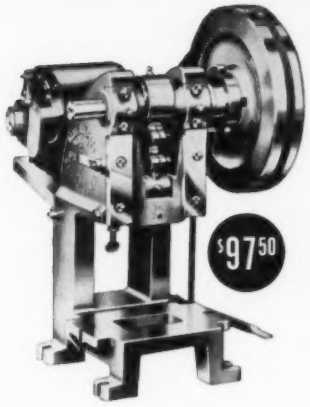
FOR SALE: Stokes #200-A 15 ton automatic molding press, perfect operating condition. Will consider exchange for DDS-2 Preform Machine. Reply Box 50355, Modern Plastics.

COMPLETE PLASTIC BUTTON MOLDING PLANT: 1—Stokes 200 Ton Model 250-A Semi-automatic Press, 2—Stokes 150 Ton Model 250-A Semi-automatic Presses, 3—Stokes RDS-3 Rotary Tablet Machines, 3—MKO 2 HP, 150 PSI Gas Boilers, 3—Buttondex Broaches, Definners, Inspection Conveyors, Tumbling Barrels, 18, 22, 24, 30 Ring Fisheye, Poker Chip and Electric Plug Molds, etc. Other Hydraulic Presses: Erie 4000 Ton and Baldwin-Southward 3600 Ton Belt Presses. Birdsboro 2000 Ton, Farrell 1000 Ton, HPM 750 Ton, Erie 700 Ton, Baldwin-Southwark 400 Ton, Farrell 393 Ton and 200 Ton, Watson-Stillman 110 Ton and 100 Ton, HPM 100 Ton and 35 Ton Molding Presses and Watson-Stillman 30 Ton Lab Presses. INJECTION MOLDING MACHINES: Various Makes, 2 oz. to 22 oz. EXTRUDERS: No. 1 Royle and larger. MISCELLANEOUS: Lab Mixers and Mills, MPM Pelletizer, Rotary Cutters, etc. JOHNSON MACHINERY COMPANY, 683P Frelinghuysen Avenue, Newark 5, New Jersey, Bigelow 8-2500. What have you for sale? What are you looking for?

400 TON HPM COMPRESSION PRESS, 4 oz, 24 oz, 32 oz. Reed, 16 oz Impco. Turner Preform machine. 10 HP Ball & Jewel Scrap Grinder. Complete plastic molding tool room, with Bridgeport Vertical Mills, #55 Index, with 2 dimensional Hydr. duplicator, lathes, grinders, drill presses, sold as lot or individually. Reply Box 53155, Modern Plastics.

(*Continued on page 252*)

CUT COSTS



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ALLEN *Punch Press*

2-Ton Power Bench Type.

less Motor

$97.50

- Powerful
- Dependable
- Economical

FREE CIRCULAR

30-Day Money-Back Guarantee.

Order TODAY. Price $97.50 F.O.B., Clinton, Mo. (Includes Motor bracket, V-belt, motor pulley, less motor).

Dealer Inquiry Invited

For light work—stamping, forming, riveting, etc.—metal, fiber or other material. Overall height 19⅜" . . . Base size 9"x8¼" . . . Die bed 6¼"x8" . . . Ram face 1½"x 3½" . . . Ram stroke ¾" . . . positive ¾" ram adjustment . . . sturdy, single pin, non-repeat hand lever clutch . . . V-belt drive . . . weight 105 lbs. Requires only 1/3 H.P. motor.

The machine of a thousand uses! Adequate for many types of work now done on large presses at greater expense.

ALVA F. ALLEN, *Dept. MP*, CLINTON, MO.

Compare!

IMS SILICONE SPRAY

FASTEST PRESS OPERATORS *WANT IT!*

COST CONSCIOUS MOLDERS *SPECIFY IT!*

Don't be fooled!

IT'S Quality IT ISN'T SIZE THAT COUNTS

All Metal Head Saves Cycle Time

Remember: IMS silicone shipments are prepaid

PRICES: (Delivered Free)	
Sample Can	$2.00
Unbroken Gross	$197.40
Unbroken Dozen	$18.00

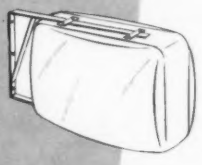
DON'T BE MISLED — LOOK OUT FOR IMITATIONS

INJECTION MOLDERS SUPPLY CO.

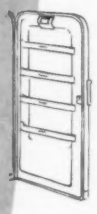
3514 LEE ROAD • WYoming 1-1424 • CLEVELAND 20, OHIO

YOU CAN SAVE BY SWITCHING TO

MIDLON

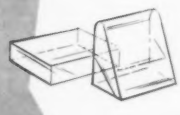


If your plastic costs are excessive . . . check with Midwest, the nation's largest and oldest exclusive extruder of thermoplastic sheet.



Here at Midwest, specialization has paid off . . . not only in quality of product but also in lowered costs. This experience coupled with volume has saved thousands of dollars for many Midwest customers.

Price, quality or service . . . whatever your problem in plastics . . . there is a Midlon sheet to fit your needs precisely. That is why "Midlon or equal" so often appears in the specification sheets of major manufacturers.



Price and product information furnished promptly upon request.

MIDWEST
PLASTIC PRODUCTS COMPANY

M P 1801 CHICAGO RD., CHICAGO HEIGHTS, ILL.

CLASSIFIED ADVERTISING

(*Continued from page 250*)

FOR SALE: One Reed-Prentice 24 ounce Injection Molding Machine. Fully equipped with 40 H.P. motor, Wheelco instruments, timers, etc. This machine is in very good condition, has had excellent maintenance and can be seen running in regular production anytime before June 15, 1955. PLASTIC MOLDED PRODUCTS CO., 6044 N. Pulaski Rd., Chicago 30, Illinois.

FOR SALE: #2 Cincinnati Centerless Grinder in good condition, $1500.00. Reply Box 53355, Modern Plastics.

FOR SALE
Lester 3S-27-12 Injection Molding Machine 12 ounce capacity. Excellent running condition, can be seen in operation.
STERLING PLASTICS CO.
1140 Commerce Avenue, Union, New Jersey

FOR SALE: 1 Kux 30 Ton Model 60 Preform Press. Running Condition. A good second Preformer. Price less drive $1,500.00. Write or wire WAHL CLIPPER CORP., Sterling, Illinois.

FOR SALE: Lester 20 ounce solid frame machine. Latest type internally heated injection cylinder. This 600 ton clamp, large die space, fast cycling machine has received excellent care and is one of those good buys. Machine installed 1950. Can be seen in operation. Reply Box 51455, Modern Plastics.

FOR SALE: 1—Farrel 60" mill; 1—Farrel 50" mill; 1—Farrel 2 roll calender 9"x20" with conveyor; 2—28" ram Dunning & Boschert hydraulic presses; 1—18" ram Farrel press; 1—14" MALM press; 1—12" ram Boschert press; 1—8" ram Watson Stillman press; 1—Farrel Refiner 20"x30"; 1—Rotex sifter, also other rubber and plastic machinery. Buying and selling. RELIABLE RUBBER & PLASTIC MACHINERY CO., INC., 2014 Union Turnpike, North Bergen, N. J. Tel.: Union 5-1073.

MACHINERY and EQUIPMENT WANTED

WANTED: Machinery including Rubber Mills, Hydraulic presses, Study mixers, Calenders, Banbury mixers, Pulverizers, Grinders, Rotary cutters, Extruders, Screens, Injection Molding machines, Dryers. Will purchase complete plant. CONSOLIDATED PRODUCTS CO., INC., 50 Bloomfield Street, Hoboken, N. J. HOboken 3-4425. N. Y. Tel.: BArclay 7-0600.

WANTED: RC 100 Windsor Stokes Extruder and other electrically heated Extruders, 2½" NRM oil heated Extruder, One 16-oz. Watson-Stillman Injection Molding Machine, Scrap Grinders and Single Punch Tablet Machines. ERIC BONWITT, 431 South Dearborn Street, Chicago 5, Illinois. Specializing in Machinery for the Plastic Industry.

WANTED: One Ounce Injection Moulding Machine. HECHLER BROTHERS, INC., 22-19 37th Avenue, Long Island City 1, N. Y.

WANTED: Used 48 or 60 oz. injection press with or without preplasticizer. Watson-Stillman or HPM. Prefer '52 model and later. Write giving specifications, number, price and delivery to Box 50755, Modern Plastics.

WANTED: 150 Ton Molding Press, Stokes R4 Preform Press, 8 oz. Injection Molding Machine, No. 3 Banbury Mixer, Calender, Extruder. Give particulars. Reply Box 52855, Modern Plastics.

4 OUNCE TO 12 OUNCE injection molding machines wanted. State make, age, condition and best price. Reply in writing to P. T. ENGINEERING COMPANY, 70 Bridge Street, Hackensack, New Jersey.

MATERIALS FOR SALE

FOR SALE: High Impact Polystyrene. You can save money by using our reprocessed high impact polystyrene pellets available in a variety of bright colors as well as matched colors. Also, bargains in bright colors cellulose acetate and other thermoplastics. 8,000 lbs. virgin gray pearl-effect polystyrene. 15,000 lbs. low priced virgin black cellulose acetate. 9,000 lbs. virgin transparent pink tinsel cellulose acetate. Samples on request. A. BAMBERGER CORPORATION, 703 Bedford Ave., Brooklyn 6, N. Y., Telephone MAin 5-7450.

FOR SALE: Teflon powder 15,000 pounds. Clean, reground to original granulation size. AMERICAN PHENOLIC CORPORATION, Harlem at 63rd Street, Chicago 38, Illinois. Telephone: BIshop 2-1000 Mr. Harry Knipp.

MELAMINE MOLDING POWDER #803-A Monsanto Chemical Flow X-12, Olive Drab. Quantity: 30,000# in 300# sealed drums. Price to sell! Samples on request. ARROW SALES CO., 633 North Myers Street, Burbank, Calif.

FOR SALE: 20,000 lbs. each Red and Blue Styrene Pellets. Surplus lot Red Acetate Pellets—15,000 lbs. Both attractively priced. We are also in the market for all surplus plastic scrap and powder. PLASTIC MOLDING POWDERS, INC., 2004 MacDonald Avenue, Bklyn., N. Y. Tel.: ES 5-7943.

FOR SALE: 23952 feet of clear lucite tubing .585 O.D., .490 I.D., 36" long, approximately 1000#. 16200 feet of black lucite tubing .580 O.D., .475 I.D., 36" long, approximately 675#. 15795 feet black lucite tubing .580 O.D., .475 I.D., 31¾" long, approximately 650#. All items priced at .15 per lb. BLAKE MANUFACTURING DIVISION, Ray-O-Vac Company, Clinton, Mass.

FOR SALE: Teflon and Kel-F rod stock in various diameters. Available approximately 30% below market value. List of sizes upon request. AMERICAN PHENOLIC CORPORATION, Harlem at 63rd Street, Chicago 38, Illinois. Telephone: BIshop 2-1000 Mr. Harry Knipp.

MATERIALS WANTED

WANTED: Plastics Scrap and Rejects of all kinds, ground and unground. Also rejected molded pieces and surplus virgin molding powders. Top prices paid. A. BAMBERGER CORPORATION, 703 Bedford Ave., Brooklyn 6, N. Y., Telephone MAin 5-7450.

WANTED: Plexiglas and Lucite scrap, salvage and cut-offs, any quantity. DUKE PLASTICS CORP., 584 Broadway, Brooklyn 6, N. Y. Tel: EVergreen 8-5520. Note new address!

SCRAP PLASTICS, all forms, waste and surplus plastic molding materials, rejects in any form. We will also buy your obsolete inventories of molding powders, stabilizers, plasticizers and other plastic and chemical materials. ACETO CHEMICAL CO., INC., 40-40A Lawrence St., Flushing 54, N. Y. INdependence 1-4100.

PLASTIC SCRAP WANTED: All types and grades, Polystyrene, Acrylic, Acetate, Butyrate, etc. Interested in both large and small accumulations. Send us a description and small representative sample, and we will quote promptly. SUCCESS PLASTICS RECOVERY WORKS, INC., P.O. Box 506, 7200 Pendleton Pike, Indianapolis, Indiana or Telephone, CHerry 2919.

SELL US YOUR PLASTIC SCRAP. Polyethylene, Polystyrene, Acetate, Ethyl Cellulose, Acrylics, Butyrate, Nylon. GEORGE WOLOCH, INC., 82 Beaver St., New York 5, N.Y.

CLEAR ACRYLIC MOLDING POWDER scrap wanted by end user either reground or unground. Also nylon molding powder scrap needed. Highest cash prices paid. Reply Box 52355, Modern Plastics.

MEDIUM SOFT OR SOFT FLOW EXTRUSION grade acetate scrap, clean and free from contamination, wanted. Reply Box 53055, Modern Plastics.

WANTED: PLASTIC SCRAP. Polyethylene scrap of all kinds. THE PETRO CHEMICALS CORP. OF NEW JERSEY, 432 First Street, Jersey City 2, N. J. Telephone: SWarthmore 5-0505.

INTERESTED IN PURCHASING odd lots of resin and off resin. Any quantity, large quantities preferred. Reply in detail sending samples and identify material offered. Reply Box 52955, Modern Plastics.

MOLDS FOR SALE

FOR SALE OR EXPORT: Metal drape and vacuum forming shell molds of Xmas items for illuminated displays. Santas (all sizes), sleighs, candles, angels, reindeer, candy canes, bells, etc. All for half of original cost. Also many other molds in stock for novelties, etc. Reply Box 54055, Modern Plastics.

MOLDS WANTED

DOLL MOLDS WANTED for 8 ounce Reed-Prentice machines. Reply Box 50555, Modern Plastics.

WE ARE INTERESTED IN PURCHASING outright or on a royalty basis injection molds in good condition that can be used for the manufacturer of advertising specialties, premiums or small toys. Send samples of items, size of mold, prices and information to Box 50455, Modern Plastics.

MOLDS WANTED: For export. All kinds of toys, household items, ladies buttons, novelties, etc., to be used in 4-8-12 oz. injection molding machine. Reply Box 53255, Modern Plastics.

PLANTS WANTED

POLYETHYLENE FILM MANUFACTURING PLANT. Will buy plant for production and sales of Polyethylene Film and Tubing. Personnel must have thorough experience in manufacturing and sales techniques and capable of handling expanded operations. Midwest location preferred. Reply Box 53955, Modern Plastics.

PLANT FOR SALE

FOR SALE
Complete wood flour mill. Capacity 10 tons per 24 hours, using nearby supply of pine and popular. For further particulars, reply Box 52055, Modern Plastics

FOR SALE: Medium size modern plant (approximately 6200 square feet) producing reinforced and vacuum molded products. Now producing custom molded products—also producing and marketing our own established line. Reply Box 51655, Modern Plastics.

HELP WANTED

WE ARE EXPANDING and have openings for men experienced in thermoplastics, in the following departments:

1) Sales and Technical Service. Buying, selling, trading. East and Midwest. Some travel, possibly relocation.
2) Research and Development on formulations, compounds, colors and colorants. New product development. Location: Brooklyn, N. Y.

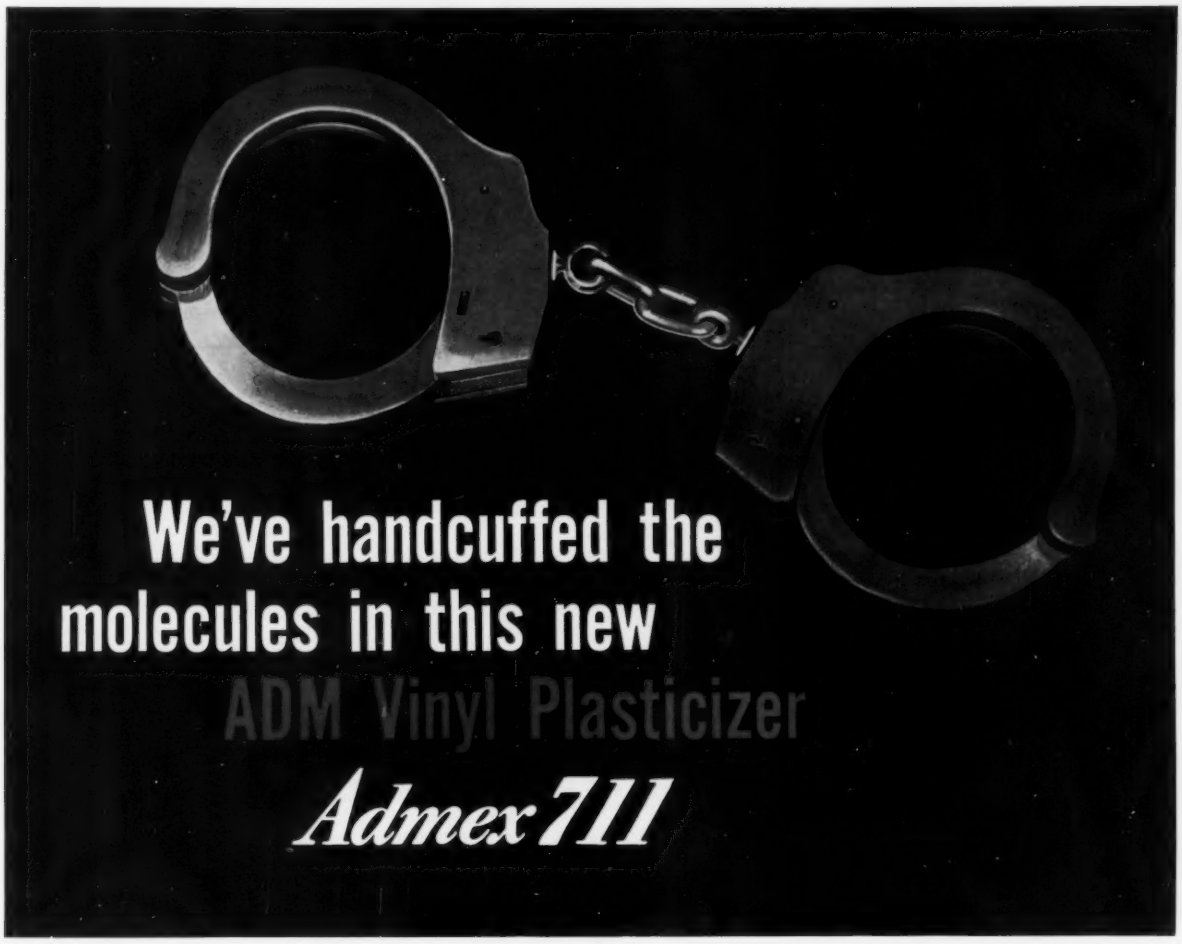
We offer the opportunity to come in on the ground floor of our rapidly growing organizations. Send resume stating salary required to Gerald F. Bamberger, Exec. V. P. All replies held in strict confidence. A. BAMBERGER CORPORATION and affiliated AMERICAN MOLDING POWDER AND CHEMICAL CORPORATION, 703 Bedford Ave., Brooklyn 6, N. Y.

WANTED: AMBITIOUS CHIEF ENGINEER for large Eastern custom molder. Imagination and initiative—experienced in plastic mold design, secondary tool design, knowledge of various molding materials and estimating. Excellent opportunity to work with top management in developing new outlets for plastics. Send complete resume with past salaries and desired salary; also photograph if available. Must be willing to relocate. For right man a wonderful opportunity is available. Reply Box 50655, Modern Plastics.

POLYETHYLENE FILM ENGINEER: With experience in the manufacture of Film and Seamless Tubing. Real opportunity for right man with sufficient knowledge to set up and run extrusion department for Midwest plastic molder. Give full details as to experience and qualifications. Reply Box 53855, Modern Plastics.

PRODUCT DEVELOPMENT and research chemist or chemical engineer with experience in production of resins and plasticizers who can take charge of newly created division in an old established business. Good chance for man with imagination and ability who wants to help create an important division of a growing plastics enterprise. Position is permanent with good pay and bonus. Reply Box 51055, Modern Plastics.

(*Continued on page 254*)



We've handcuffed the molecules in this new ADM Vinyl Plasticizer *Admex 711*

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(*Continued from page 252*)

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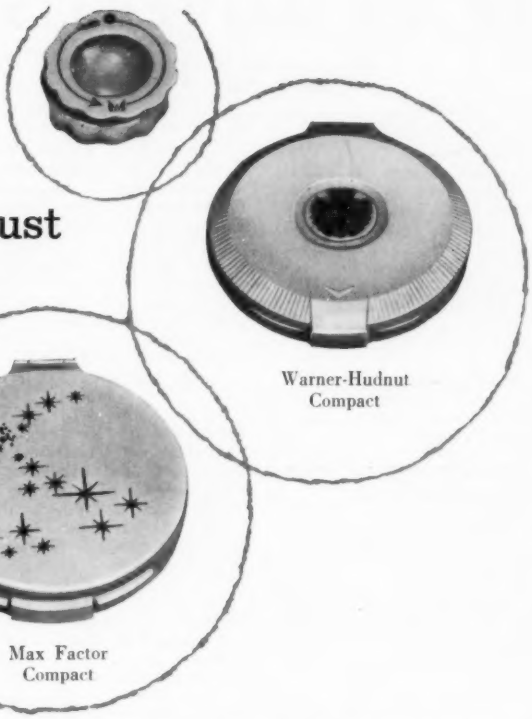

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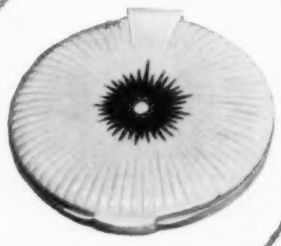

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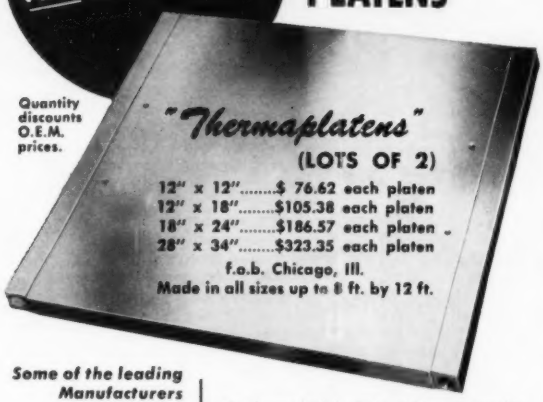

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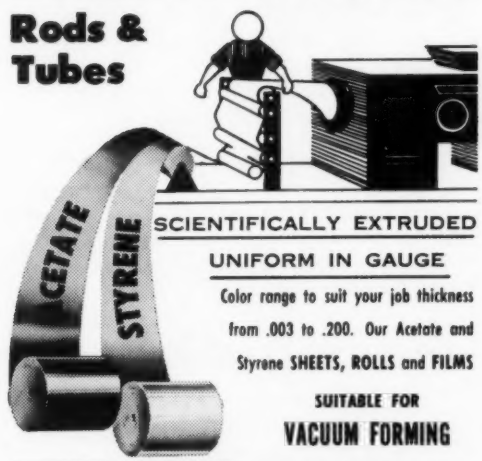

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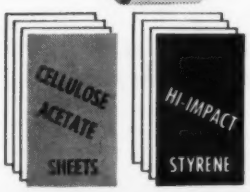

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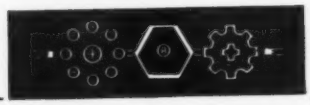

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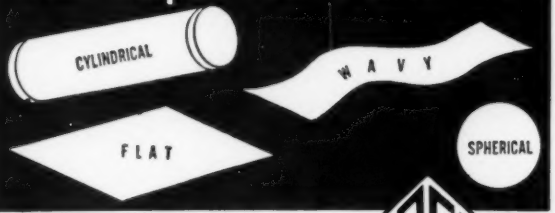

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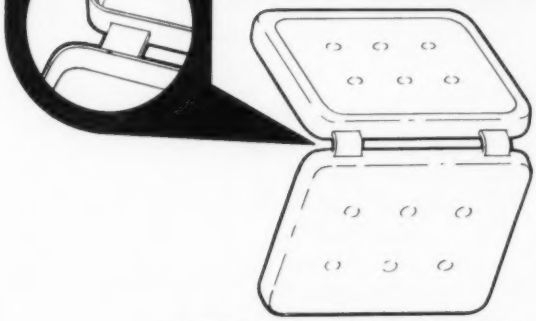

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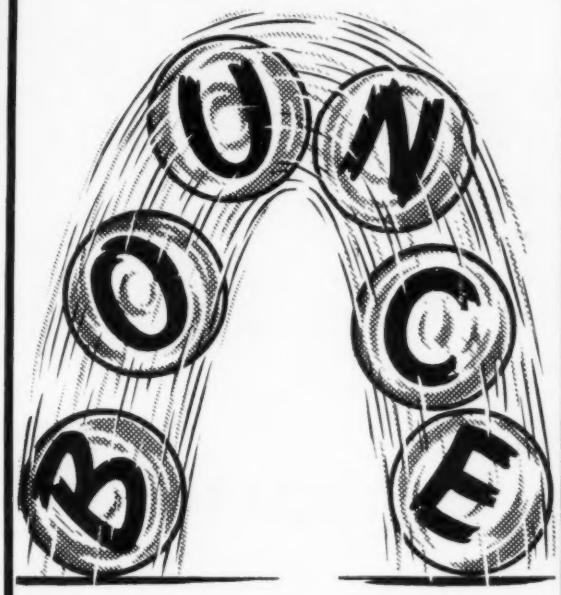

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We manufacture other plasticizers which also impart high resilience to the finished product, but for the cost per pound of plasticizer nothing equals KP-220 in inches of bounce.

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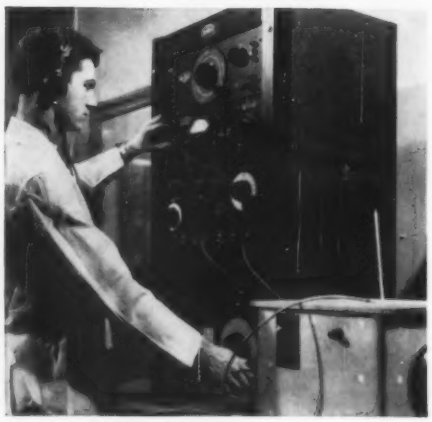

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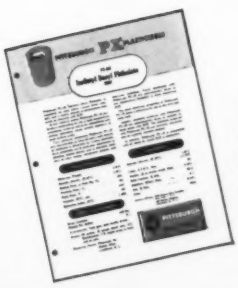

For more information on Pittsburgh PX-118 IsoOctyl Decyl Phthalate, write today for Technical Bulletin No. 118.

WBD 5243

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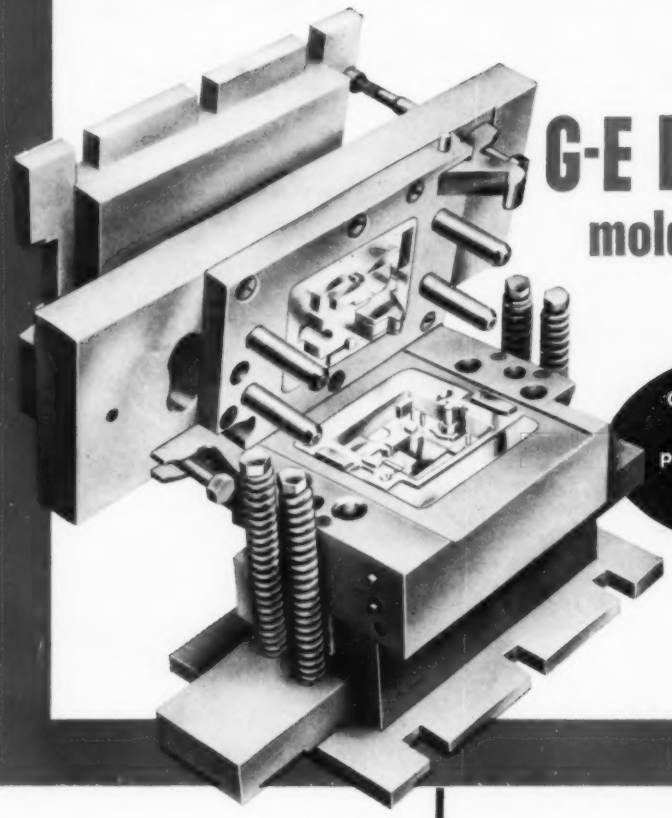

Gates and runners of transfer molds are particularly susceptible to erosive wear!

COMPARE!

Here is the erosion ratio of the new G-E compound compared with five other leading grades of conventional phenolic material tested by G.E.

COMPOUND	G.E.	A	B	C	D	E
EROSION RATIO*	0.15	1.0	6.3	1.7	2.6	3.3

*Erosion ratio is a numerical value expressing the measured erosive characteristics of the given compound; the lower the value the less erosive is the compound.

When conventional compounds were used, an expensive transfer mold had to be returned to the repair shop every six weeks—*because of the abrasive action of the compound.* Then the molder switched to a General Electric *low-erosion* phenolic molding compound. Result? *Fourteen* uninterrupted weeks of production—*over 60%* less down time for welding and costly refinishing!

How much is mold erosion costing *you?* It is estimated that molders lose approximately $2,000,000 each year from this cause. Through radioactive tracer techniques, G.E. has developed compounds *which may reduce this erosion as much as 60%!*

For complete information—and samples of G-E low-erosion molding compounds—just write to *General Electric Company, Section 521-3A, Chemical Materials Department, Pittsfield, Massachusetts.*

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